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JUNE 1994

BYTE

THE MAGAZINE OF TECHNOLOGY INTEGRATION

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An Easier Way To Develop Lotus Notes Applications PAGE 40

80x86 WARS

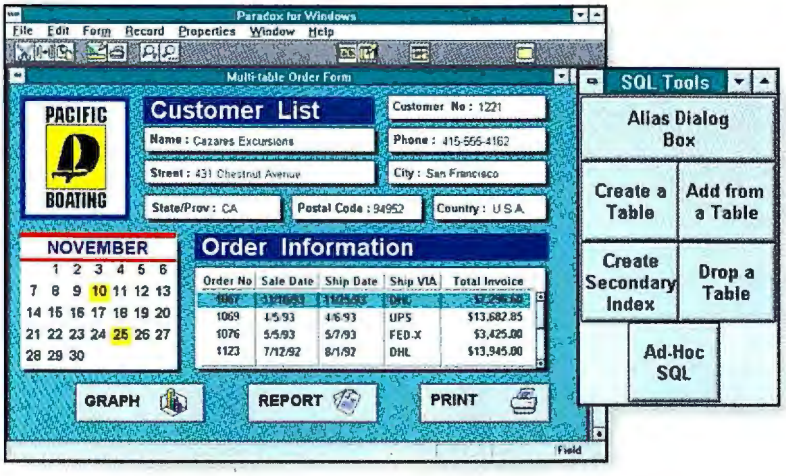
Coming: radical new designs from Intel and others will push the 80x86 architecture to new heights.



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Object-oriented development environment	Yes	No
Supports SQL pass-through	Yes	No
Built-in workgroup support	Yes	No
Complete Paradox and dBASE file support	Yes	No

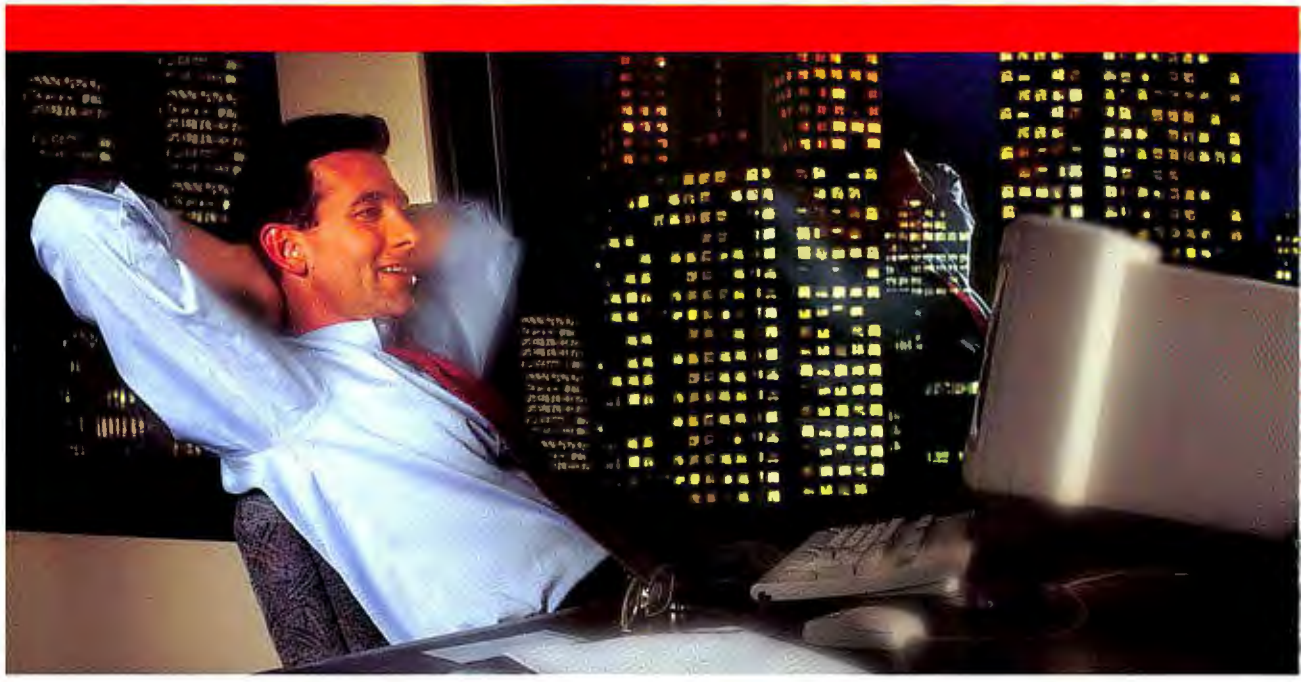
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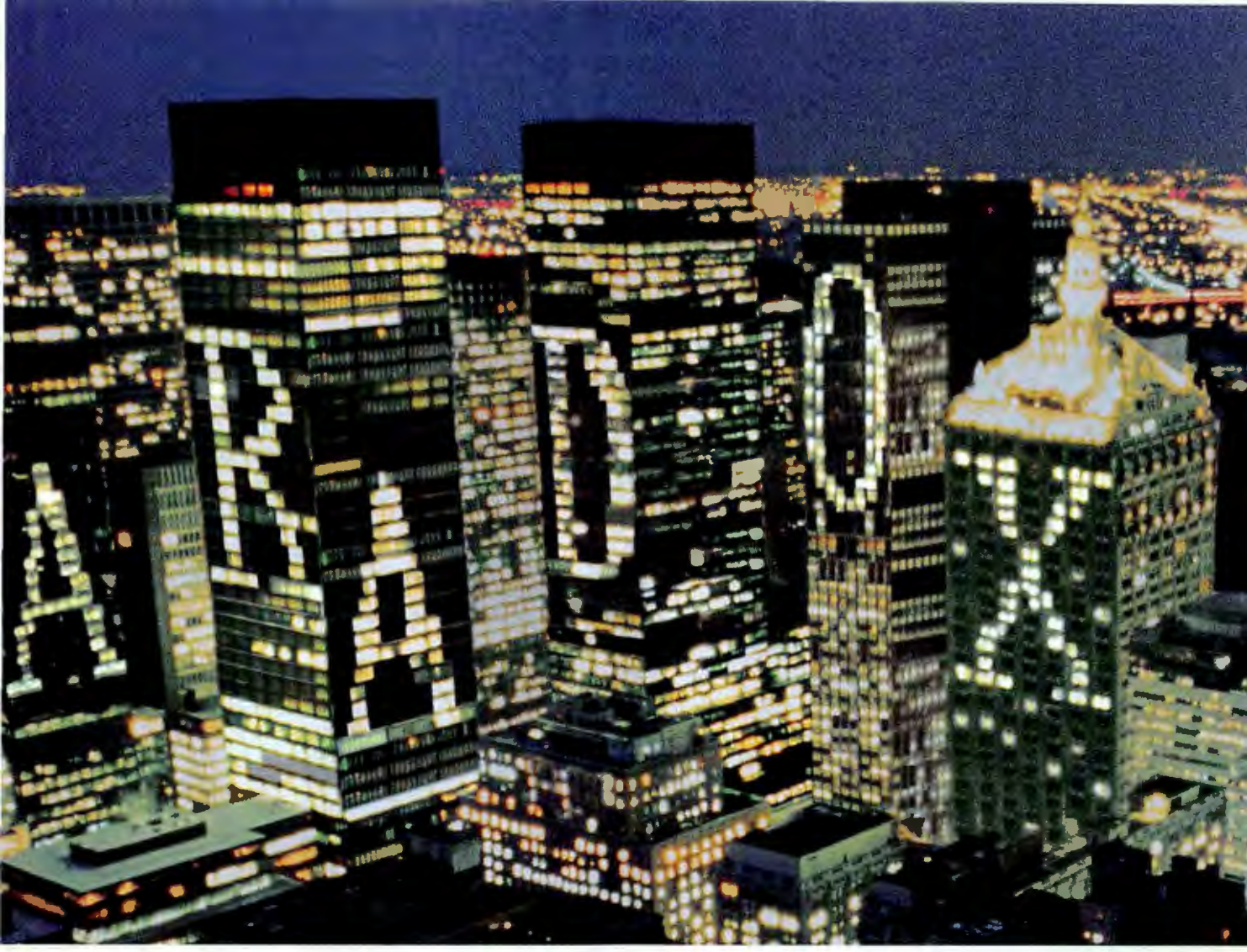
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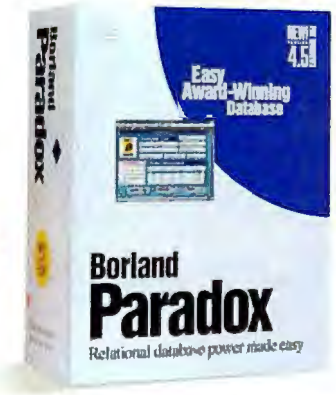
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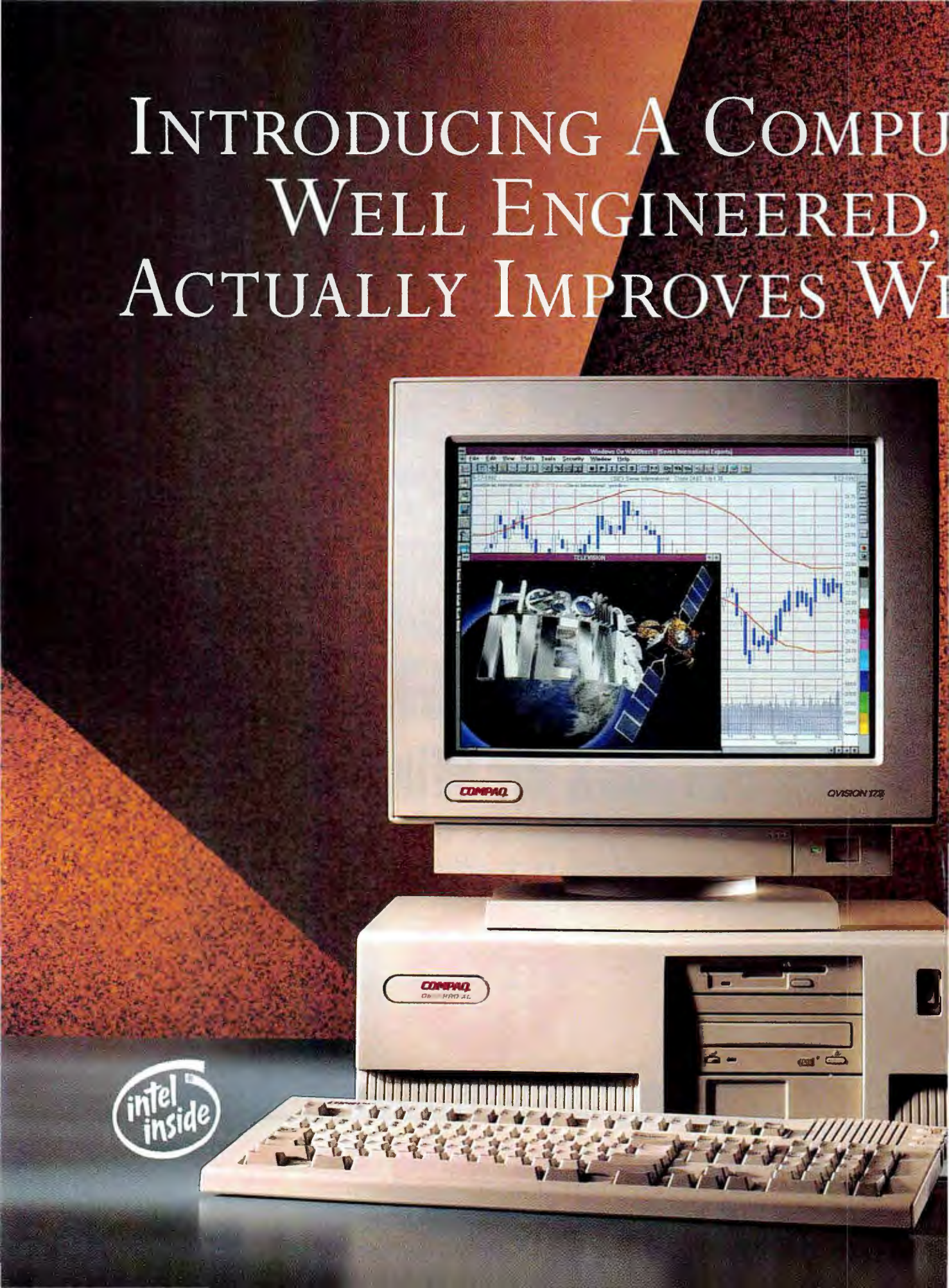
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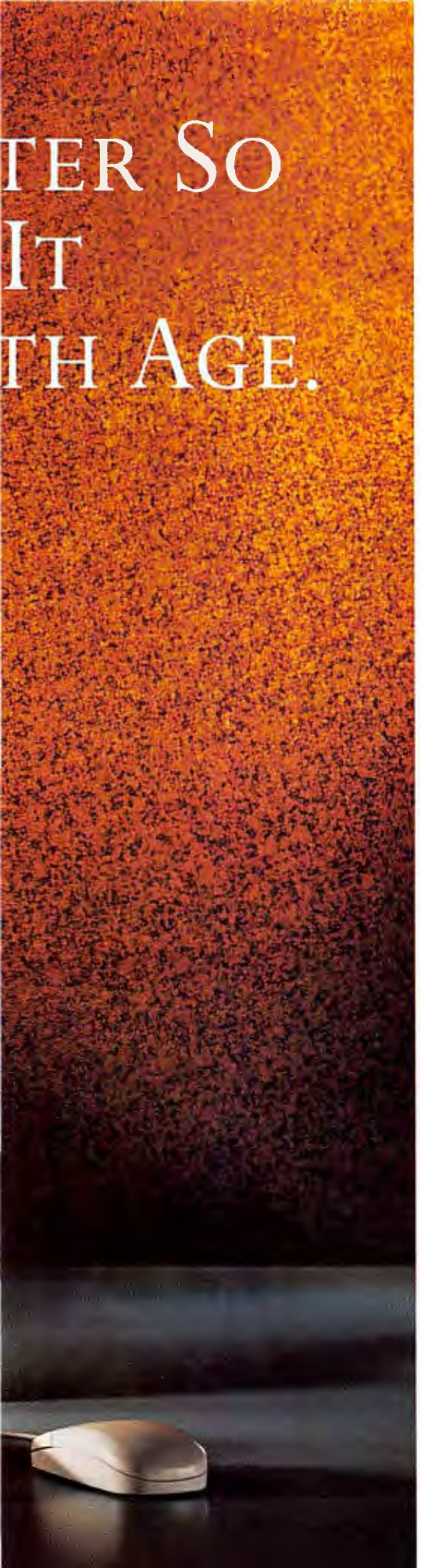
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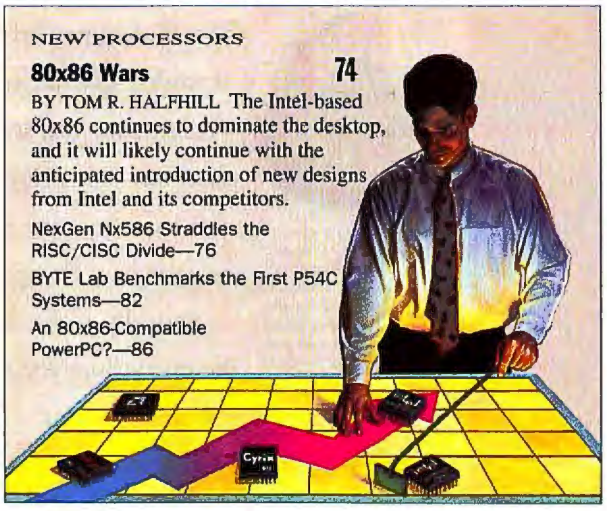
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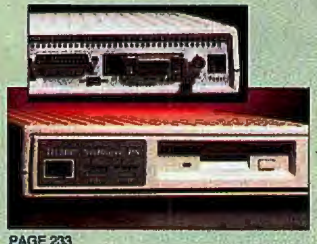
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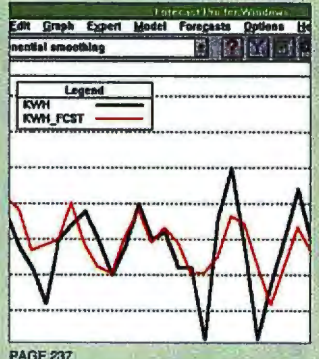
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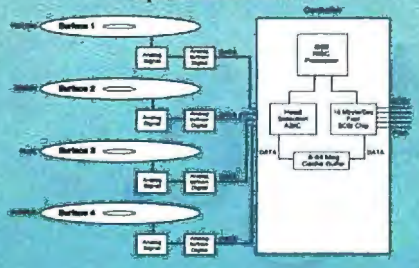
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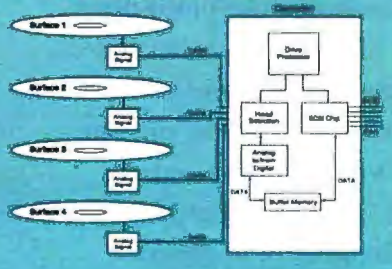
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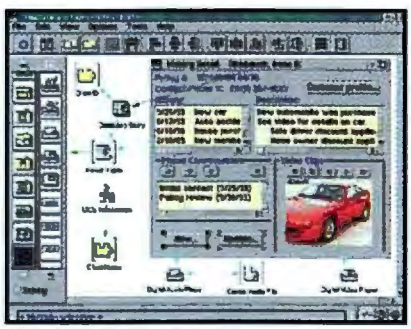


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Core Technologies in BYTE



We introduce a new section that will bring you monthly coverage of the four most critical technology topics

This month, I am proud to introduce a new section in BYTE called Core Technologies. Each month, this new section will bring you specific coverage of four major technology topics: CPUs, operating systems, networks, and programming.

For the section's debut, our CPU coverage (page 265) is on the newest version of the PowerPC, the 100-MHz 604 chip, which promises to be 50 percent faster than Intel's 100-MHz Pentium P54C. Bob Ryan and Tom Thompson, who have closely followed the PowerPC for BYTE, provide a technical overview of the 604's six execution units. Three of those execution units are integer pipelines, and as the authors point out, in the PC world where integer performance is everything, the PowerPC 604 is the first microprocessor to have three pipelines dedicated to integer functions.

Our operating-system coverage (page 267) is on IBM's implementation of SMP (symmetric multiprocessing) in OS/2. No, we're not talking about IBM's Workplace OS, which was designed to support SMP. We're talking about a retrofit of SMP support onto OS/2 2.1. Naturally, IBM had to make some compromises, but as Michael S. Kogan (author of *The Design of OS/2*) points out, OS/2 SMP should deliver real scalability to OS/2 programs.

For our network coverage (page 271), BYTE's Ben Smith provides a primer on PPP (Point-to-Point Protocol), which is popular for long-distance network connections. If you are not familiar with PPP, you'll want to get up to speed with this protocol that is already implemented in many commercial software packages and hardware.

In the programming arena, our coverage (page 273) is on porting Macintosh applications to the PowerPC. Rick Grehan, who is technical director of the BYTE Lab, discusses some changes that programmers need to consider, such as lost support of the 80-bit extended floating-point type, the change from code *segments* to code *fragments*, and mixed-mode programming.

The idea for the Core Technologies section came from BYTE readers, who continually tell us they read BYTE for the technology. We read that in the mail you sent and in the surveys you answered. We also learned it through the formal focus groups we've had with readers and the many informal dinners we've had with groups of BYTE readers. Again and again, we heard that you are most interested in technology coverage—and you've let us know that accurately covering technology is BYTE's core competency. That's why we are introducing the Core Technologies section, so that each month you can be certain of staying abreast of the four most critical technologies. Frankly, we couldn't be happier. BYTE started its move back to its technical roots just over two years ago, and you've told us that we are on the right track. This June issue indicates our commitment to supply you with the most authoritative information on technology and technology integration possible.

Look at our cover story on the 80x86 wars (page 74), for example. BYTE's senior news editor on the West Coast, Tom R. Halfhill, provides an insightful look at new CPUs from AMD, Cyrix, Intel, and NexGen that promise to extend the life of the 80x86-compatible architecture. Each manufacturer has its own ideas on how to retain compatibility while moving forward with RISC-like features and giving Intel a run for its money.

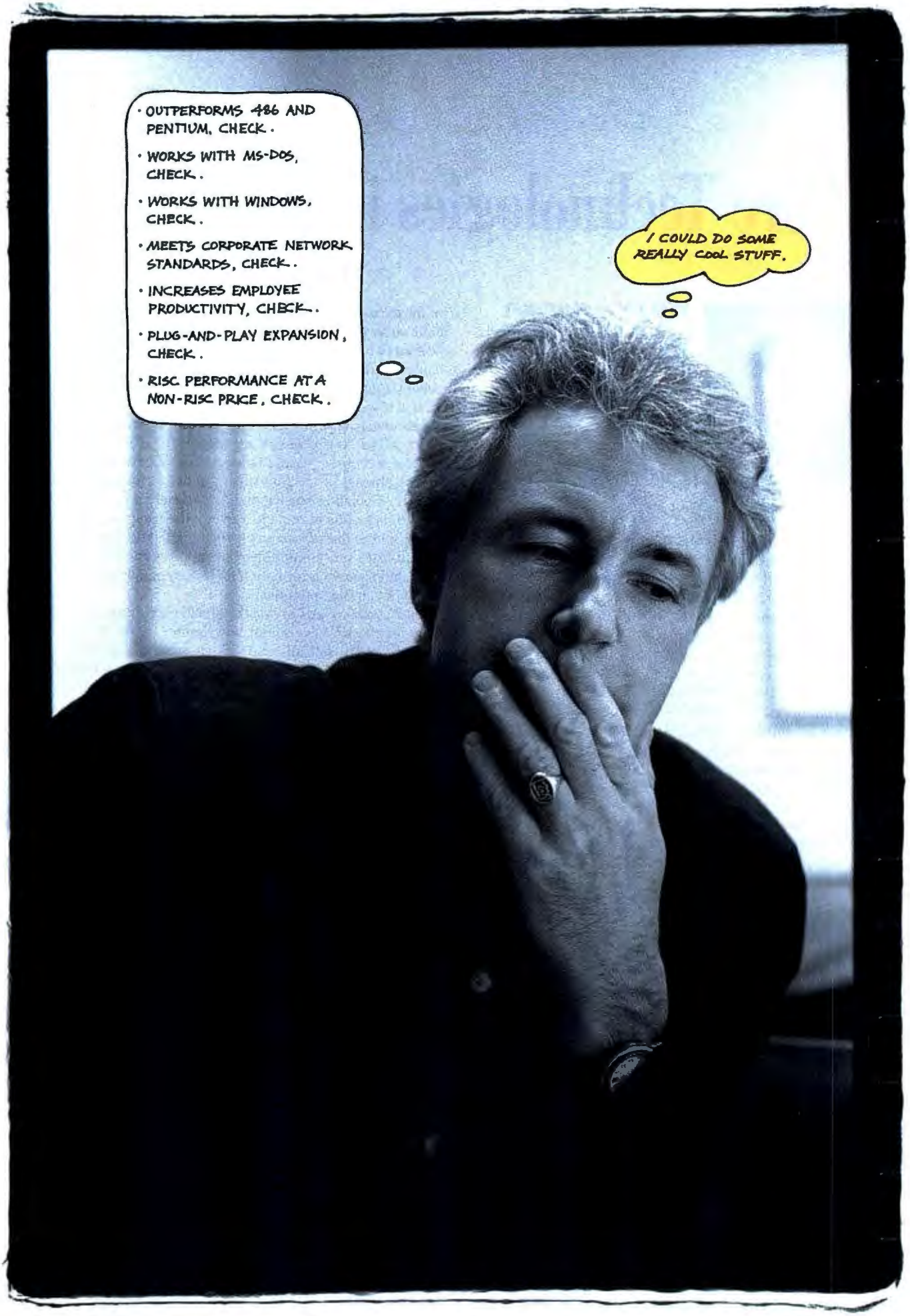
Also check out our special report on distributed computing (beginning on page 121). We have devoted a large number of pages to topics such as the OSF's Distributed Computing Environment, data distribution, managing storage, security, and remote connections. Given the changing paradigm of enterprise-wide computing, you cannot afford to miss this special report.

Finally, to make sure that we continue to stay in touch with your needs, we ask you to fill out the short questionnaire on page 276 to help us shape our network management coverage for an upcoming issue. Each month, you'll find a similar questionnaire about an upcoming topic. You probably saw the first of these questionnaires in last month's issue. Your answers will greatly help our editors. n

P.S. I'd like to welcome BYTE Thailand, which debuted in May, as the newest member of the BYTE family.



DENNIS ALLEN, EDITOR IN CHIEF
(dallen@bix.com)


• OUTPERFORMS 486 AND PENTIUM, CHECK.
• WORKS WITH MS-DOS, CHECK.
• WORKS WITH WINDOWS, CHECK.
• MEETS CORPORATE NETWORK STANDARDS, CHECK.
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But that's just the beginning. "By the end of 1994," wrote *PC/Computing*, "you'll see



From left, the Power Macintosh 8100/80, Power Macintosh 7100/66 and Power Macintosh 6100/60.

Effective 3/14/94. Apple Price includes the Power Macintosh 6100/60 with 8MB of memory and a 160MB hard drive. For the sake of custom configuration, keyboard, monitor and mouse are sold separately. Videos bundled with a particular configuration. SoftWindows must be purchased sepa
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PowerPC systems for less than $2,500 running Macintosh, Windows, DOS and native applications that make Pentium look like a draft horse."

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Introducing Power Macintosh.

Apple

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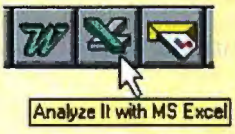
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Letters

Powerful PowerPC Coverage

You have once again proven to be the best journal in the field. Your coverage of the Power Mac hardware (April) left all I read in the Mac magazines and what information I could get out of an Apple representative far behind. Thanks for the work.

Martin Rommel
Cambridge, MA



I would like to compliment Tom Thompson and Bob Ryan on their superb cover story on the new PowerPCs. The article was completely objective, mentioning that the Power Macs are powerful but don't outperform most workstations. And what I find most pleasing is the depth of the coverage on the systems to be released by IBM's Power Personal Systems division. I have yet to see any other periodical discuss these systems and their PReP (PowerPC Reference Platform) specification with as much detail and accuracy as does BYTE.

Pooya Hemami
Montreal, Quebec, Canada

Virtual Conversation on Virtual Legality

I agree with attorney Victor Cosentino (March Commentary) that E-mail contracts would be easy to fake. However, everyday voice-phone transactions are made and memorialized, if at all, on scrawled bits of paper with the potential of being ambiguous and self-serving. Yet the vast majority of oral contracts follow through to mutually successful conclusions because most people are in business not only to make money but to stay in business. That depends on a reputation for keeping your word and delivering acceptable quality. Consentino's specific advice, "E-mail should not be used to create a contract" is just backward and unhelpful. He could have been more helpful by telling people how to structure E-mail transactions, so problems of proof and payment can be avoided.

Jim Upchurch
Montgomery, AL

Many of the points you raise are correct; nevertheless, I stand by what I said. Voice phone is a good way to initiate and negotiate contracts, but when a contract involves the sale of goods valued at more than $500, most states have laws specifically stating that such contracts must be in writing and signed in order for them to be enforceable. The bottom line is that as a businessperson, you need to know the risks inherent in the way you run your business, including the possibility that someone might stiff you on an E-mail contract that is not enforceable in court.

—Victor Cosentino

In "Virtual Legality," Victor Cosentino concludes that a contract formed through the exchange of E-mail, without a cryptographic "digital signature" is probably not legally enforceable. With all professional respect, I disagree. First, although the statute of frauds requires certain contracts to be "signed," the law generally understands that word to be flexible. The law does not require that symbol to be secure against forgery, and many courts have held that simple telegrams are signed. Second, to enforce an E-mail message, you must prove its origin, but that does not necessarily require a digital signature. A famous example occurred in the Iran-contra trial of Admiral John Poindexter. In none of these cases was the message in question authenticated with a digital signature but rather on the basis of a log-on password used to send the message and, more important, the facts and circumstances of the case (e.g., testimony from a witness: "He told me he was going to send me E-mail, and then I received this message..."). Readers should, of course, consult their own lawyers.

Benjamin Wright
Author of The Law of Electronic Commerce: EDI, Fax, and E-mail *(Little, Brown and Company, 1992)*
Dallas, TX

Recognizing Wright's expertise in the field, I maintain that E-mail agreements (within the statute of frauds) are probably unenforceable in court. Although the court does interpret "signed" broadly, it would be a great mistake to accept the "from" field in plain-text E-mail as a signature. Taken out of the network, an E-mail message is just editable text, easily fabricated. The comparison to telegrams seems inappropriate. Telegrams are relatively trustworthy, because individuals must go through an intermediary that delivers a fairly unalterable hard copy to the recipient. And the Poindexter case involved multiple messages sent over a long period of time rather than just those necessary to make an offer and acceptance. Furthermore, those messages were sent and received within a government communications network designed for top federal administrative officials rather than the anarchic Internet whose standards are designed to support the lowest common denominator. Also, in that case, the E-mail message was not considered under the strict sense of the statute of fraud. The gist of my article was the presence of unquantified and unidentified risk of which users may not be aware. Perhaps, the risk is quite small. However, unless the potential loss is also small, contracting by E-mail is a risk I advise my clients not to take.

—Victor Cosentino

¡Hola, Amigos!

With all this talk of the free trade agreement, you'd think mail-order companies would take advantage of the right-next-door million-dollar market of Mexico by providing toll-free numbers for direct buyers. The opposite is true. In a study conducted of more than 50 computer publications that we receive at the University of Mayab, we found only one international toll-free number out of over 300 direct-sales companies. Interestingly enough, that one is a flourishing Texas company, which assured us it has been selling directly to Mexico for over five years with great success and profit. Computer companies across America, "drop us a line," and if it's toll-free, all the better.

James Mulford
Vice President, University of Mayab
Mérida, Yucatán, Mexico

Development Much Needed on the Data Highway

I have been a long-time, hard-core computer user for over 15 years in the international environment. I have moved more

We want to hear from you. *Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458; or you can send E-mail via the Internet or BIX at editors@bix.com. Letters may be edited.*

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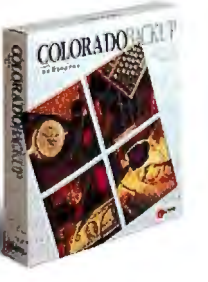


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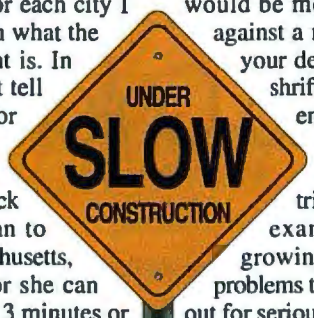
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than 10 times from one country to another, and my job requires that I travel to more than 17 countries. I feel it's the small things that have to get straightened out first for the traveling "road warrior." It's fine to talk about how to get video and sound across continents (March cover story), but our first concern should be, How will we plug into this network? So let's get back to basics. For each city I travel to, I have to research what the nearest dial-in access point is. In the Boston area, I couldn't tell you if Boxborough, Stow, or Cambridge is closer to Westford or to Maynard. Perhaps a simple reality check would be for an American to travel from Boston, Massachusetts, to Bangor, Maine. If he or she can send an E-mail message in 3 minutes or less on arrival at either location, we'll be ready to start talking about how best to take advantage of fiber-link bandwidths.

Alan Scarboro
Geneva, Switzerland



I have read with fascination about the information super highway in recent BYTE issues. Being a resident of Kenya, where it's difficult to get a clear phone line (dedicated or not) to the next building, let alone the next town, BYTE sure puts things in perspective.

Jerry Tribe
Nairobi, Kenya

Technically, your data-highway article is up to the good standards I expect from BYTE. But socially? There's enthusiastic, multipage descriptions of commercial plans, profit making for vendors, and spending opportunities for affluent consumers. But where did the promised social issues (e.g., how it should be built) go?

Usage-based billing, as intended by tollway builders, puts pressure on users to reduce their connection time. One fee for unlimited connection, as today on the Internet, makes people adapt an "it's paid for, use it" mentality. This leads to the strong participation that has made the unique culture of the Internet. I have the impression that the government has chickened out in front of politically motivated cost-cutters and industry lobbyists. The citizens are again going to be the losers. Gore's vision of information bettering society looks hollow when you consider how one-sided it is being implemented.

Neil Franklin
Winterthur, Switzerland

In Need of a New Paradigm

Mobile computing has reached critical mass, and yet I have been disenchanted with coverage in BYTE and in other PC magazines regarding this major emerging product category for several years. You tend to treat mobile PCs as if they were desktop systems, but somehow less. In fact, they are very different, and it would be most helpful to judge them against a mobile paradigm. Yet with your desktop bias, you give short shrift to technologies that differentiate these smaller systems, even as you heap praise on all their desktop-like attributes. Take PCMCIA, for example. Yes, PCMCIA has growing pains and compatibility problems today, but the topic also cries out for serious and continuous coverage, and except for fax/modem and network-adapter announcements, it is not getting that coverage from BYTE.

Frank Keresztes-Fischer
Brighton, MI

When evaluating portable computers, we use and heavily rate criteria that are important to mobile users. For instance, in the March lab report on portables, we evaluate size, weight, battery life, communications tools, and pointing devices. We also stress the importance of a portable's ability to connect to external monitors, its suitability for giving presentations, and availability of PCMCIA slots. Furthermore, we use a notebook computer as the baseline system when comparing benchmark results. —Eds.

Chicago: An Ambitious Compromise

I enjoyed reading your informative article on Chicago (March News & Views). The article mentions Eicon Technology's NABIOS redirector as an example of the kinds of services that will perpetuate DOS dependencies in Chicago. While this is true today, Eicon has recognized the limitations of TSRs in the Windows environment. We have developed a DLL version of the NABIOS redirector (named ECLAN) and will include it in all new products. Users of our Windows applications will no longer need to load TSRs to access the InterConnect Server family.

Lionel Gibbons
Director of Product Management
Eicon Technology
Montreal, Quebec, Canada

FIXES

In "Building the Data Highway" (March), we said TCP/IP is a routed, connectionless datagram protocol. IP is connectionless, but TCP is not; thus, TCP riding on IP is not connectionless, although UDP/IP is.

In our March letters page, we incorrectly expanded the acronym NIC to network interface card. Instead, it should have read the Network Information Center, which distributes ranges of IP addresses. ■

COMING UP IN JULY

- **PARALLEL PROCESSING**
  The TAOS operating system harnesses the power of multiprocessors, even processors with different architectures.
- **GROUPWARE APPLICATIONS**
  Are the work-flow processes worth the reengineering effort?
- **NETWORK MANAGEMENT SOFTWARE**
  The BYTE Lab evaluates inventory control, remote configuration, software metering, deployment, and LAN monitoring, as well as diagnostic and repair utilities.
- **27 V.FAST AND V.32TERBO MODEMS**
  Just how fast are they? How well do they hold a line? Fax? Interoperate?
- **TECHNICAL DOCUMENT MANAGEMENT**
  Does your company manage technical documents effectively and efficiently? We examine ways to do so.
- **DATA ACQUISITION TOOLS**
  Controlling data acquisition hardware from Windows may not be as simple as vendors would have you think.

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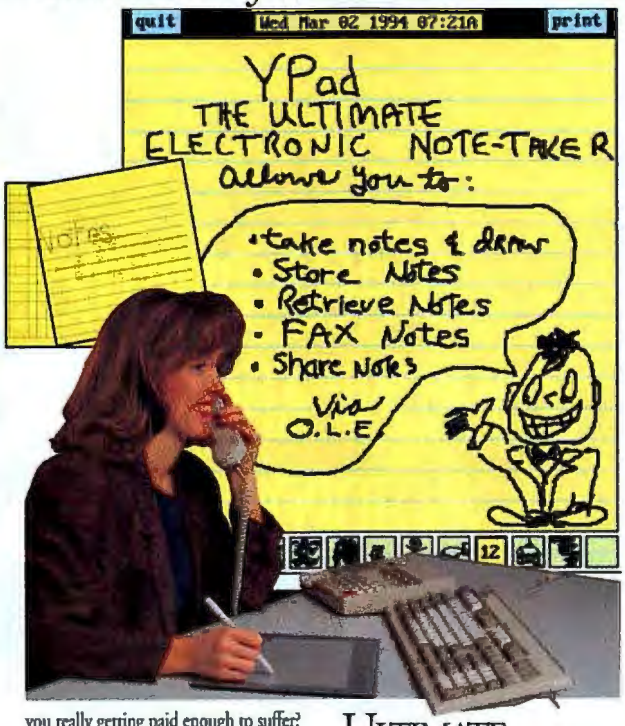
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Gestures are special pen strokes that perform specific editing functions, such as the cut gesture for deleting selected text.

Gestures are special pen strokes that perform specific editing functions.

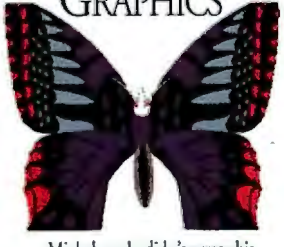
You spend at least 80% of your document-creating time editing. Highlighting, changing words with gestures you already know, moving text, spellchecking, pointing and clicking will make your pen the ultimate keyboard complement.

The Ultimate Physical Therapist



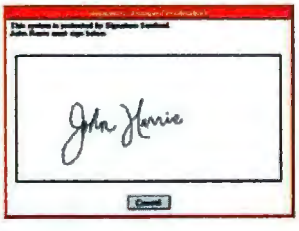
Tired of hurting, sitting in a rigid, cramped position using the mouse? Are you really getting paid enough to suffer? 56% of all OSHA reported injuries are RSI, or Repetitive Stress Illnesses. The recommended physical therapy for wrist and tendon problems is making a fist. Kind of like you'd do holding a pen. Pen computing is a very healthy complement to your computer keyboard. And to your life.

Ultimate Graphics



Michelangelo didn't create his Sistine Chapel masterpiece with a ball peen hammer. Why constrain your own creativity with a mouse? Handwriter lets you draw or trace with ease and works perfectly with your graphics software.

Ultimate Security: Your Signature



Why try to remember all those different passwords — and changing them periodically — when Handwriter for Windows comes with signature-verification security built into a screen saver? People may *try* to trace your signature, but it's virtually impossible for them to duplicate the stroke dynamics you used to write it. Signature-verification security makes a Handwriter the ultimate complement to your keyboard, especially in environments where many people have potential access to work areas.

"... and its handwriting recognition is the best we've ever seen." March 1994, *PC Computing*

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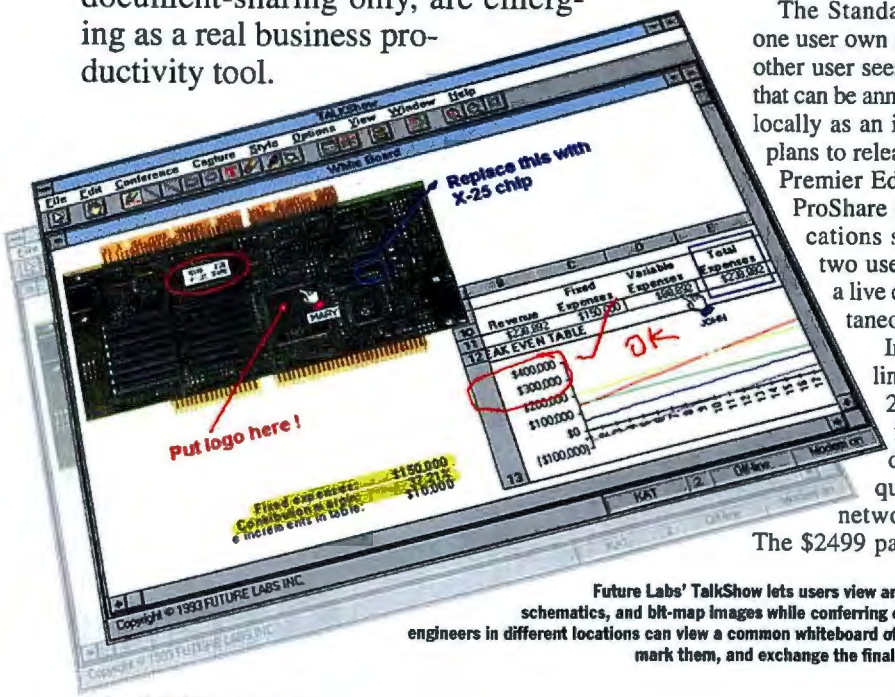
VIDEOCONFERENCING

Desktop Conferencing Takes Off

Update: A new round of desktop conferencing products foster group collaboration and could fuel demand for ISDN

ANDY REINHARDT

Hardly a month goes by without a new product introduction in the fast-growing desktop videoconferencing and document conferencing market. Once merely a whizbang technology seen in cartoons or at world's fairs (see "Video Conquers the Desktop," September 1993 BYTE), desktop conferencing applications, whether video-based or document-sharing only, are emerging as a real business productivity tool.



Future Labs' TalkShow lets users view and update documents, schematics, and bit-map images while conferring on the telephone. Two engineers in different locations can view a common whiteboard of selected documents, mark them, and exchange the final modified documents.

Among the most noteworthy new entrants is a family of products from Intel ((408) 765-8080) called ProShare Personal Conferencing. The entry-level Standard Edition sells for $99. It's a software-only solution that allows shared whiteboarding and documents, but no video, over an ISDN or analog telephone line.

The Standard Edition lets one user own a document; the other user sees a bit map of it that can be annotated and saved locally as an image file. Intel plans to release this month a Premier Edition ($299) of ProShare that adds applications sharing, so that two users can work on a live document simultaneously.

Intel's top-of-the-line Video System 200 adds support for a video window and thus requires ISDN or a network connection. The $2499 package includes ISA data compression/decompression and ISDN cards, a small video camera, an earphone, a microphone, and software. Some regional telephone companies will distribute the product, including Pacific Bell, which says it will sell Intel's package for $999 to customers who subscribe to a new ISDN line.

Intel has hinted that it will support other platforms with ProShare, including the Mac. The company is leading an effort to develop cross-platform interoperability standards for desktop videoconferencing.

A competitor to ProShare comes from start-up Nuts Technologies (San Jose, CA, (408) 441-2166, and Hong Kong), whose Connect 918 ($4299; $5899 with the ISDN card) offers document sharing, file transfer, a shared whiteboard, and videoconferencing. The program currently runs on the Mac. A Windows version that is planned for release this spring will let Mac and Windows users hold desktop conferences. Connect 918 runs over LANs or ISDN or analog telephone lines.

Connect 918 includes an H.261-based compression/decompression board, a microphone and loudspeaker, a camera, and an optional ISDN terminal adapter. The latest Mac version (a Windows follow-up is also planned) adds resizable windows and the ability to change the frame rate during a session. In the future, Nuts aims to support more than two users at once in a shared session.

Other competitors include InVision from InVision Systems (Vienna, VA, (703) 506-0094) and NTV from Peregrine Systems (Carlsbad, CA, (619) 431-2400). Both companies' products operate in Windows and make extensive use of desktop standards. InVision combines videoconferencing and document conferencing, uses TCP/IP protocols, and supports a wide range of LANs and WANs (wide-area networks). It now uses Action Media II (i.e., DVI) data compression and will reportedly

support H.261 compression in the future.

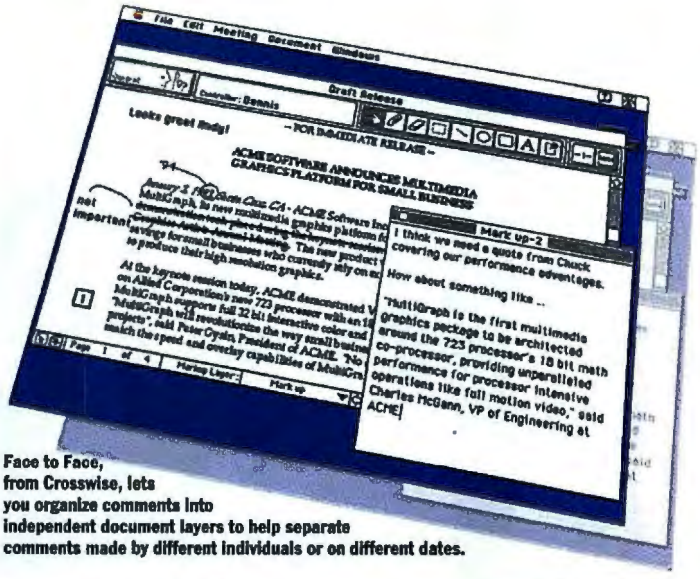
NTV now works only over LANs and uses Microsoft's Video for Windows as its video format. For a full conferencing and screen-sharing system, you equip a standard 386DX/25 or higher computer with off-the-shelf video- and audio-capture boards, as well as a camera (e.g., the VideoLabs Flexcam), microphone, and speakers. For systems that only receive video and do screen sharing, you can skip the video-capture card because Video for Windows can decompress in software. NTV sells for $299. According to Peregrine, this means you can add a complete videoconferencing system to a PC for less than $1000 per seat, assuming a $250 camera, $300 video card, $15 for a microphone/headset, and $100 for a network card.

For systems integrators who are looking to create their own videoconferencing solutions, Optibase (Dallas, TX, (214) 386-2040, and Herzliya, Israel) sells the Superboard, an SVGA video card with NTSC and PAL video input, an IIT H.261 codec, MPEG and JPEG compression support, a fax modem, and a bundled Windows DLL for custom-developed applications.

SunSolutions (Mountain View, CA, (415) 336-4567), a Sun Microsystems company, has plans this year to port Show Me 2.0 from its Solaris/SPARC base to Solaris 80x86, Unix variants on Hewlett-Packard and IBM RISC workstations, and Windows. Show Me 2.0 supports videoconferencing, audioconferencing, document and applications sharing, and whiteboarding. Prices range from $899 to $3270 for a single-user license.

In the Solaris/SPARC, AIX RS/6000, and HP-UX environments, InSoft's Communique supports shared whiteboarding, shared applications, and videoconferencing. InSoft (Mechanicsburg, PA, (717) 730-9501) is promoting its own API for cross-platform videoconferencing, called DVE (Digital Video Everywhere), and plans to release by July versions of its software for Windows and Windows NT on DEC Alpha systems.

Desktop conferencing does not require video, however. Many vendors contend that workgroup applications that provide audioconferencing and document sharing only—without the "bobbing heads" you often get in digital video applications—offer a cost-effective way for people to collaborate. One solution that eschews the video window is Face to Face from Crosswise (Santa Cruz, CA, (408) 459-9060). The software, which Crosswise claims is the first such package to interoperate between Windows and the Mac, costs $295. It runs on AppleTalk LANs or ISDN or analog telephone lines. Face to Face lets two users view and annotate documents as they talk on the phone. It includes an address book, a control panel, and meeting management. For record keeping, a file is automatically generated for each session that includes the names of the participants, copies of the shared documents, and all annotations. Crosswise has established partnerships with Apple and Pacific Bell.



Face to Face, from Crosswise, lets you organize comments into independent document layers to help separate comments made by different individuals or on different dates.

Another contender in software-only conferencing is TalkShow from Future Labs (Los Altos, CA, (415) 254-9000), which now runs only on Windows. Version 2.0 adds support for WANs (via TCP/IP and IPX protocols), whereas before it ran only on NetBIOS, and accommodates multiple users in a single session. It also supports more graphics file formats and JPEG image compression. One of the most attractive aspects of the $199 package is that you can distribute an unlimited number of temporary "guest" copies to remote users who want to participate in a document conference but don't own TalkShow. Another software-only contender comes from WorldLinx (Toronto, Ontario, Canada, (416) 350-1000), which sells the $195 Vis-a-Vis in DOS, Windows, and Mac versions.

The emergence of better and less expensive compression technologies, widely installed networks and ISDN lines, and a growing demand for collaborative computing tools have thrust video and audiographic applications into the spotlight. After years of evangelizing ISDN, U.S. phone companies may finally have the "killer application" that will stimulate demand for digital telephony.

Standards Efforts Aim to Ease Incompatibilities

Several standards efforts are under way in the conferencing market, aimed at enabling interoperability, creating opportunities for new vendors, and pulling down prices. Driven by some of the biggest names in the business, including Intel, Lotus, AT&T, Hewlett-Packard, and MCI, these specifications will help fuel acceptance of desktop videoconferencing and document conferencing.

Standard	Purpose	Pros	Cons
H.320	Describes video compression, audio, and call setup formats.	International standard.	Complex; expensive to implement; requires switched digital services like ISDN.
Intel Personal Conferencing Specification	Describes audio, document, data compression, and cross-platform file standards.	Supports video software decompression due to Intel's Indeo video technology.	Not supported by Apple or IBM.
Consortium for Audiographics Teleconferencing Standards	Working to promote the ITU.TSS standard T.120 multipoint audiographic conferencing standard.	Cross-platform; network independent.	Requires two separate analog telephone lines.
AT&T Paradyne's VoiceSpan (also known as Simultaneous Voice/Data)	Technology for audiographic conferencing that splits a single analog telephone line into two virtual channels.	Multipoint; allows simultaneous audio and data transmission.	Audio quality; data-transmission speed can degrade.
Radish Communications Systems' VoiceView	Technology for multiplexing voice and data over a single analog telephone line.	Can be added to some existing modems through firmware upgrade; inexpensive; backed by Microsoft.	Voice and data not simultaneous.



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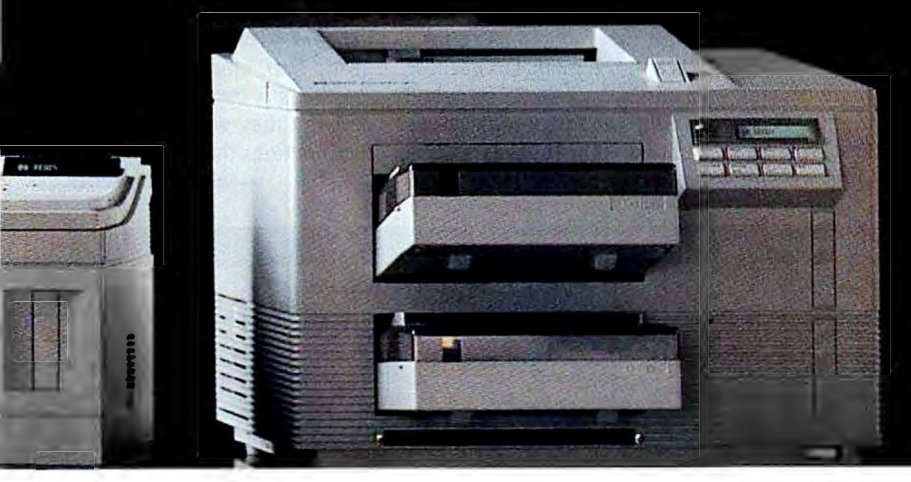
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ETHERNET NETWORKING

Switching Hubs Get Their Due

When it comes to providing bandwidth for applications like multimedia and video over LANs, ATM (Asynchronous Transfer Mode) gets all the attention. Somewhat overshadowed by ATM products, although now starting to get the respect they deserve, are Ethernet switching hubs. These let a company ease network bottlenecks and save money by not having to upgrade workstation adapter cards or installed network cabling.

Al Herrington, the communications manager at St. Jude Children's Research Hospital and a beta user of the ONcore Switching System from Chipcom (Southborough, MA), says the switching hub integrates easily into his network, "and the learning curve is almost zero." Because virtually all major hub vendors offer upgrades to ATM via modules that you plug into a hub, today's Ethernet switching hubs offer a stepping-stone to ATM.

In the past nine months, many leading router and hub vendors that lacked switching technology have acquired companies that have it. Cisco Systems (Menlo Park, CA) acquired switching-hub vendor Crescendo Communications, Network Systems (Minneapolis) acquired Bytex, 3Com (Santa Clara, CA) acquired Synernetics, and Chipcom merged with switching-hub vendor Artel Communications.

Cisco recently introduced its Catalyst switching hub, the first product from its relationship with Crescendo. Optical Data Systems (Dallas, TX) and Kalpana (Sunnyvale, CA) have partnered to integrate Kalpana's EtherSwitch technology with ODS's Infinity intelligent switching hub.

Traditional hub vendors such as Cabletron Systems (Rochester, NH) and Santa Clara–based Synoptics Communications are also releasing products. Cabletron scheduled a May release for its Multi Media Access Center-Plus, a fault-tolerant switching system that incorporates ATM and delivers aggregate bandwidth exceeding 10 Gbps, providing 500 ports of connectivity and 160 LAN segments. Cabletron's ESX-MIM MMAC module already supports the company's switching technology called Secure Fast Packet Switching, which incorporates Ethernet and ATM switching technologies. Similarly, Synoptics' Lattis System 5000 intelligent hub will integrate the company's ATM, Ethernet switching, and ATM/Ethernet translation technologies into one platform over the second half of this year.

Ethernet switching offerings from other hub vendors include the LANswitch family from Lannet (Irvine, CA), which are cards for Lannet's Multinet hub; Kalpana's EtherSwitch EPS-1500; the Powerhub from Alantec (San Jose, CA); the Elite ES/1 from Standard Microsystems (Hauppauge, NY); and the Series 6000 with its PowerSwitch module from Networth (Irving, TX).

Ethernet switching hubs are also coming from start-ups that have expertise in switching or high-speed networking, such as fast Ethernet pioneer Grand Junction (Fremont, CA), whose FastSwitch gives 25 switched 10-Mbps end-user connections and two 100-Mbps fast Ethernet server connections. Other products are the EIFO Client/Server Switching Hub from FDDI (Fiber Distributed Data Interface) specialist Network Peripherals (San Jose), the SH 516 from NBase Switch Communications (Chatsworth, CA), and WaveSwitch from Plaintree Systems (Wellesley, MA). The SH 516 and WaveSwitch connect multiple Ethernet segments to fast Ethernet networks.

Hub capabilities vary widely (see the chart). The EIFO product sells for about $8000, while Cabletron's switching modules alone can cost $8000 or more each, with hubs selling from $12,000 to $50,000. However, enterprise hubs usually support a higher number of LAN segments per switching module and workstations per segment than workgroup hubs do. Thus, enterprise hubs typically offer greater flexibility and management functions at costs of about $300 to $400 per port over a typical workgroup hub. One way to separate hubs is by the size of the network they will service and the functions they support.

—Salvatore Salamone

What to Look For in Hubs

Type of Ethernet Switching Hub	Configuration	Properties to Look For	Possible Disadvantages	Examples of Switching Hubs
Workgroup	Server on FDDI or fast Ethernet backbone connected to multiple LAN segments.	Connections to high-speed LANs like FDDI and fast Ethernet. Low cost.	May not be expandable. May not provide for migration to other switching technologies. May not offer adequate network management tools.	EIFO Client/Server Switching Hub from Network Peripherals. FastSwitch from Grand Junction.
Departmental	Several dedicated applications servers on one or more FDDI or fast Ethernet backbones connected to high-powered workstations or Ethernet LAN segments.	Filtering. Ability to set broadcast fire walls. Fault-tolerant capabilities like hot-swappable components and redundant power supplies.	May not offer centralized management functions found in enterprise switching hubs.	DragonSwitch from Ungermann-Bass. LANplex 5000 from 3Com. Galactica from Artel.
Enterprise	Same as departmental, but with added ability to set up virtual workgroups. May be a mix of Ethernet switching and ATM.	Advanced network management capabilities. Security features. Migration path to ATM. May include routing functions.	Cost per port typically higher than that of workgroup hubs.	PowerHub from Alantec. LANplex 6000 from 3Com MMAC from Cabletron. LANswitch from Lannet. Elite ES/1 from SMC.

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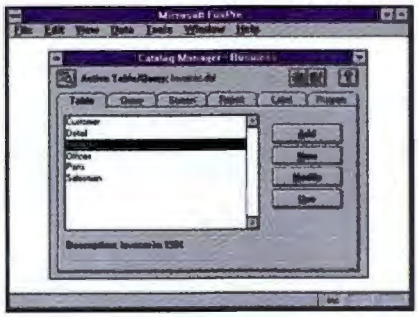
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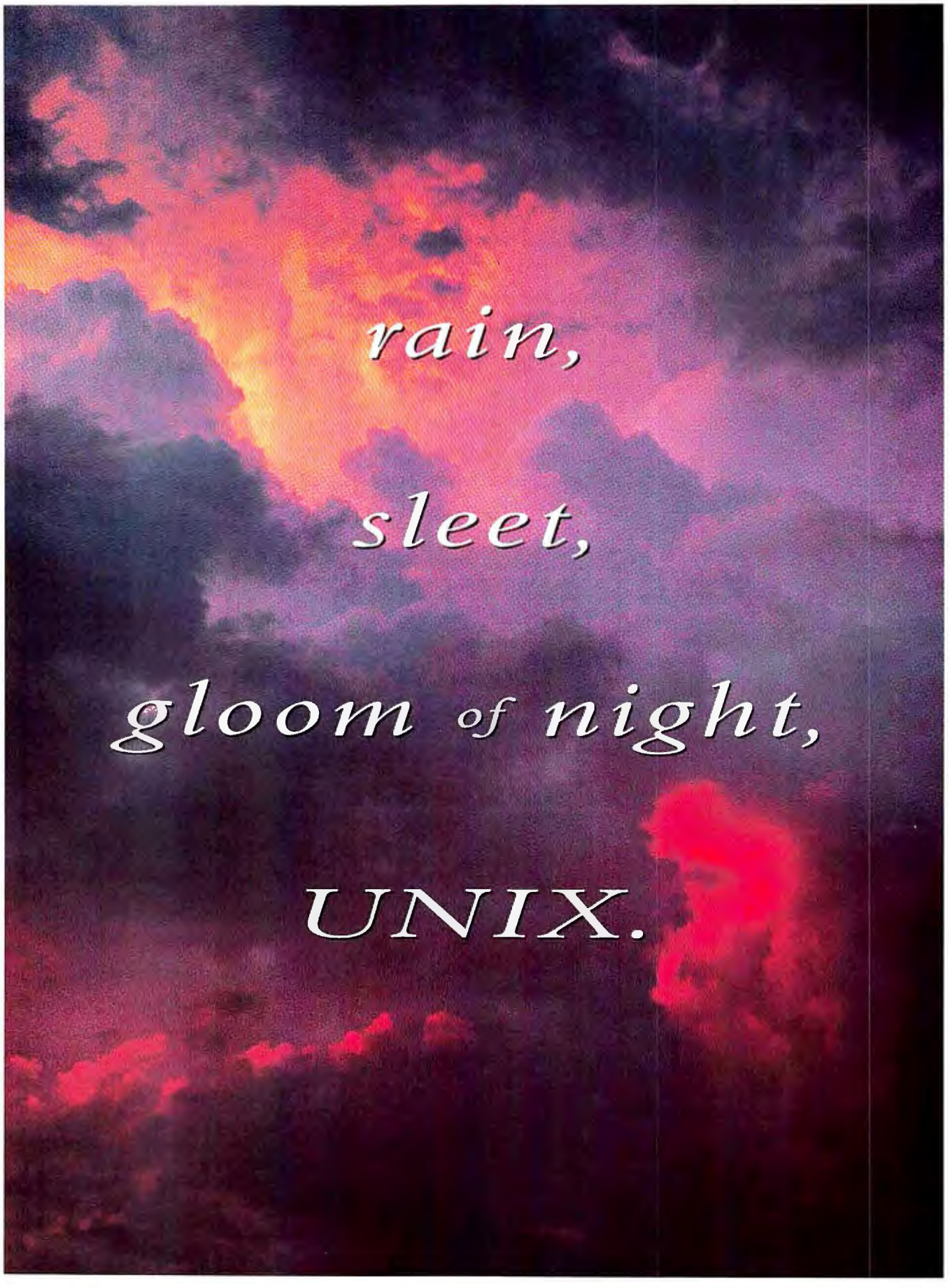
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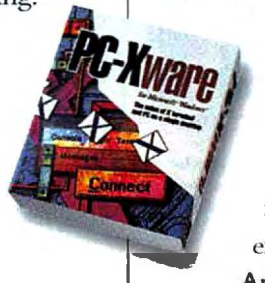
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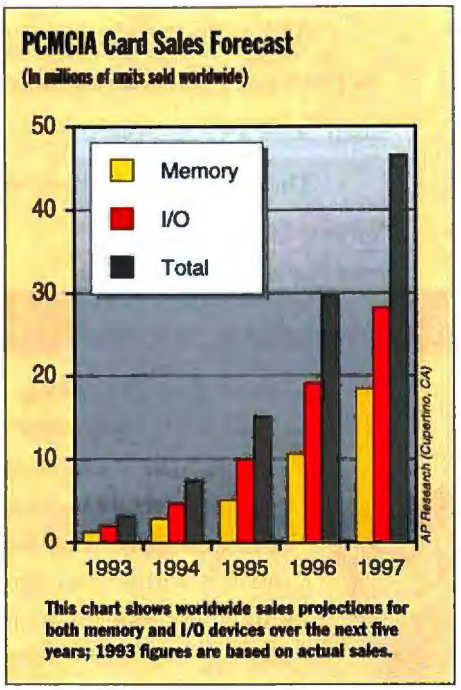
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PCMCIA STANDARDS

The Memory-Card Manager Grows Up

As committee members work on a new PCMCIA specification that will add bus mastering, a 32-bit data path, and 3.3-V operation, users continue to grapple with incompatibilities in current products. PCMCIA devices are getting closer to full interoperability across different PCs. But users of PCMCIA fax modems, LAN adapters, and other devices are finding that the reality of 100 percent compatibility approaches the goal only asymptotically—coming ever closer but never arriving.



This chart shows worldwide sales projections for both memory and I/O devices over the next five years; 1993 figures are based on actual sales.

Today's PCMCIA scene features a mixture of PCMCIA devices that may work perfectly well with one brand of PC but not with another. "Let's face it, the [PCMCIA] spec was originally designed as a memory-card manager," says Ray Bridenbaugh, marketing manager for American Megatrends (Norcross, GA), a company that develops system motherboards, BIOSes, and peripheral cards. "PCMCIA is not like PCI [Peripheral Component Interconnect]. The PCI spec needed little revision. But PCMCIA has now become a broad application bus, and this evolution of use has resulted in a challenge in maintaining compatibility across all applications."

Other incompatibilities can occur with devices that implement features not specified in the specification, such as the so-called Type IV, 16-mm cards. Toshiba's T4600 and T4700 notebooks have a 16-mm slot that accepts the company's dual-RJ-11-port modem. But the modem won't fit in standard Type I, II, and III slots.

Dan Sternglass, president of Databook (Ithaca, NY) and head of the PCMCIA committee's compatibility task force, offers a simple rule for solving compatibility problems: Call your PC vendor to see if the PCMCIA device you want to buy will work with your PC, and use the latest drivers. "If people do that, they find that most everything out there works."

A more permanent solution revolves around the PCMCIA committee's efforts to tackle compatibility issues, which include developing a minimum required function set for the CIS (Card Information Structure). The host chip and card services use the CIS to properly set up IRQs (interrupt requests), I/O memory base, and other settings. Eventually, the committee hopes to make PCMCIA cards compatible across hardware platforms.

Compatibility will become more important as PCMCIA's popularity increases as a peripheral standard. "All of a sudden, this neat technology has a solid marketing purpose that will help drive it into legitimacy," says Bridenbaugh. "The stepchild has been adopted."

—Ed Perratore

NETWORK BACKUP

Vendors Work to Cure Incompatibility Blues

Incompatible backup storage formats are a big problem for many businesses. Although the physical formats that govern how data is laid down are identical in a given backup medium, a brand X drive might not be able to read a tape produced by a brand Y drive due to differing logical-medium formats that define things like file header information. Also, a vendor's products can be incompatible across different operating systems.

Backup software and hardware vendors hope that a new standard, SIDF (System-Independent Data Format), will make these compatibility problems obsolete. SIDF 1.0, based on Novell's SMS (Storage Management System) data format, is currently being presented for acceptance by the ISO. Key backup and operating-system vendors like Exabyte, Palindrome, Novell, Mountain Network Solutions, and Cheyenne Software support SIDF. But Microsoft, which has its own Microsoft Tape Format standard, has not publicly endorsed SIDF.

SIDF supports DOS, Unix, NetWare, OS/2, and FTAM (File Transfer, Access, and Management) file systems, but it can be extended to support others. Although SIDF will most affect tape backup, it can be applied to both sequential (e.g., tape) and nonsequential (e.g., hard and CD-ROM drives) media.

SIDF-capable products are shipping now, but they won't solve storage-compatibility problems overnight: Media must be recorded in SIDF to achieve cross-platform compatibility. Rerecording old tapes is costly and time-consuming, but it's worthwhile for some companies, according to Jeff Platòn, chairman of the SIDF Association. He says the less attractive alternative is to keep your older equipment—drives, backup software, and perhaps the operating system—on hand to read non-SIDF archived data.

"SIDF is probably the wave of the future," says James McNeil, executive vice president of business development at Cheyenne Software. But he adds that Cheyenne will also support its proprietary tape format, because the company cannot assume that its current customers will immediately convert to SIDF.

—Michael Nadeau

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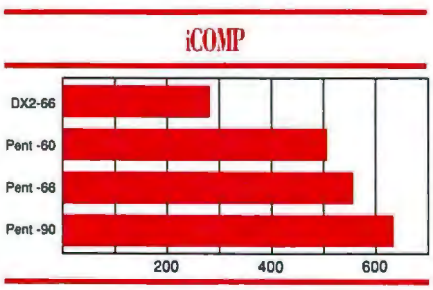
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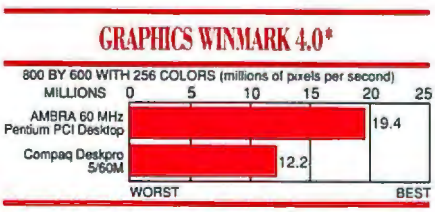
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POINTING DEVICES

Apple, Cirque Unveil Trackball Alternative



Cirque's GlidePoint brings the oldest pointing device—your finger—to PCs and notebooks. Instead of rolling a trackball or mouse, you drag your finger across the GlidePoint's motion-sensitive surface. Apple is using a similar technology in its new Mac PowerBooks.

Apple's new Mac PowerBook 500 notebooks will introduce an innovative pointing device that essentially has one moving part: your finger. Instead of rolling a ball as you would with a mouse or trackball, with Apple's new trackpad pointing device, you move your finger across a pad. The trackpad doesn't have any moving parts and doesn't require you to disassemble it to clean it. Instead of pointing and clicking, you point and tap with the trackpad.

Two layers of measurement electrodes built into the pad's surface are arranged in a checkerboard pattern that creates a series of intersections. The presence of your finger lowers the capacitance at the closest electrode intersections and modifies the signal received by the sense electrodes. The trackpad compares the current location of low capacitance, then compares it to the previous location, and moves the cursor accordingly. The trackpad's resolution (250 points per inch) allows cursor control down to the pixel level.

The new pointing device is not limited to PowerBooks. Cirque (Salt Lake City, UT, (801) 467-1100) says it will sell a similar device called the GlidePoint that plugs into a PS/2 port for $99. Cirque is also pursuing other manufacturers.

BYTE editors tested a preliminary version of the GlidePoint and found it should be especially useful in areas that restrict you to a limited range of motion, such as on an airplane. One potential drawback: The trackpad is so smooth that you don't get much tactile feedback. Any passive-matrix notebook, including the new PowerBooks, tends to lose the cursor when you move it quickly across the screen. With the passive-matrix/trackpad combination, you may find yourself looking up at the screen a lot more at first.

—Dave Andrews

OS/2 on the PowerPC Slated for This Year

As Microsoft continues development on Windows Chicago and Daytona (a new version of Windows NT with a smaller RAM requirement), and Apple works to add multithreading to System 7.5, IBM is working on new versions of its operating systems as well.

By the end of the year, IBM plans to release its first Microkernel-based Workplace OS product for the PowerPC, which is in essence OS/2 running on the PowerPC. OS/2 for the PowerPC was slated to enter beta testing in June.

IBM says it is now in beta testing of a symmetric multiprocessing version of OS/2 that it hopes to release this summer. "Eight-MB systems would be comfortable running this," says Ayodele Anise, OS/2 SMP development manager.

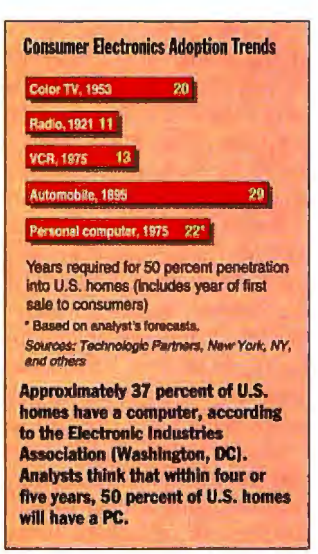
IBM also has plans for a trimmed-down, faster version of OS/2 for Intel, but executives were mum on further details. A representative would say only that "IBM is starting to customize OS/2 for specific needs."

—D.A.

1994	1995	1996
OS/2 2.x	**OS/2 1995**	**OS/2 1996**
(OS/2 for Intel)	(OS/2 for Intel)	(OS/2 for Intel)
"Lite" version	Taligent layers	Taligent R2 layers
SMP version		Full DCE
Distributed SOM-objects II		
OpenDoc		
Security		
Systems Management		
Plug and Play		
Workplace OS	**Workplace OS**	**Workplace OS**
(OS/2 for the PowerPC)	(OS/2 for the PowerPC)	(OS/2 for the PowerPC)
OS/2 2.x on the IBM	Taligent layers	Taligent R2 layers
Microkernel	Full DCE	
Integrated Pen/Speech	SMP	

PC TRENDS

Entertainment, Education Help Drive Home PC Acceptance



Approximately 37 percent of U.S. homes have a computer, according to the Electronic Industries Association (Washington, DC). Analysts think that within four or five years, 50 percent of U.S. homes will have a PC.

Although computers dominate the business scene, they have not achieved the same success in the home. "At the home level, the computer is too difficult to learn how to use," says Joe Walsh, CEO of the Resource Finance Group (Grand Rapids, MI). RFG sells a 486-based multimedia system called the i-Media for about $3500. It can play full-length CD-I (CD Interactive) movies on a big-screen TV thanks to an on-board MPEG decompression chip and S- and composite-video output.

Figures from the Software Publishers Association confirm heightened interest in multimedia-capable machines from home buyers: PCs equipped with a CD-ROM drive accounted for 37 percent of home computers that were bought in 1993–1994, versus 19 percent in 1991.

The percentage of sound-card-equipped PCs bought for the home increased from 4 percent to 19 percent over the same period. "Productivity is a justification [for a home PC]," Walsh says. "But once people get the box inside their house, the thing that they're buying is entertainment."

—D.A.

PERSONAL DIGITAL ASSISTANTS

Users: Give Us Connected PDAs with PCMCIA

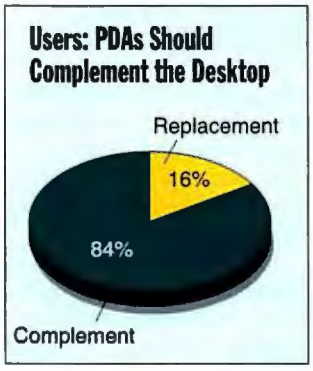
Call it a strategic pause in the PDA (personal digital assistant) market. Although Apple has released a new MessagePad and Motorola says it will start selling a communications-centered personal communicator this summer, major players like Compaq are still evaluating what users want in a PDA.

BYTE surveyed about 30 current or former users of the Tandy/Casio Zoomer, Apple MessagePads 100 and 110, or Sharp Electronics' ExpertPad. Through the survey and follow-up interviews, BYTE came up with a 10-point wish list for next-generation PDAs.

No tiny PC clones. More than half of those surveyed responded favorably to the notion of scaled-down versions of desktop applications. But in follow-up interviews, several users bristled at the notion of a flat-out, scaled-down PC that would dilute the PDA's convenience and value. "No one is going to want to run WordPerfect [on a PDA]," says Greg Kearney, the owner of a MessagePad and a Zoomer and assistant systems administrator for the *Casper Star-Tribune* (Casper, WY).

Connect it to the desktop. Ken Wallich, user-interface group leader at Network Computing Devices (Mountain View, CA), switched from the Zoomer to the Apple MessagePad 110 because of the latter's ability to connect to his Mac.

Focus the applications. Ed Denhoff, facilities manager for a large financial organization, generally praises the Zoomer but questions the Tandy/Casio development team's encoding of documents (e.g., the U.S. Declaration of Independence) into ROM. Denhoff says that ROM space could serve better purposes, such as terminal emulation and fax capability.



A recent survey conducted by BYTE indicates that users see PDAs as a complement, rather than as a replacement, for their desktop computers.

Other respondents want applications with smart agents. Doug Miller, a principal of the management consulting and organizational development firm Reser Miller, says such an agent would read his appointment schedule, note an upcoming sales call, log on to an on-line service, download information about that company, and alert him 15 minutes before the call.

Make them faster. "When you're sitting at a table, at a meeting, or [talking] on a telephone, you have to be able to [access data] right now," says Bill Laird, assistant vice president of American Systems Engineering.

Receive faxes, not just send them. The MessagePad 110 permits the sending of faxes natively; the Zoomer, via America Online. But there are problems inherent in receiving faxes because of the PDA's memory restrictions (i.e., faxes can be only one to two pages long) and remote nature. Faxes may require routing through a desktop system or a third-party store-and-forward service that knows how to reach you when you're on the road.

Tell us where we are. Several respondents said that they would purchase a GPS (global positioning system) on an add-on PCMCIA card today. They wouldn't have to pay a high premium for a car with similar GPS technology.

Programming to go. Users want programming modules to help the occasional, as opposed to professional, developer write custom applications and extend the PDA platform.

Subscription services. In the survey, users were tepid in their desire for subscription services. Zoomer users, for example, can already get headlines via America Online. But many on-line services (e.g., AT&T's PersonaLink and Apple's e*World) won't be up and running until later this year. Kearney pictures a program that would download an electronic newspaper each morning into his PDA, so he could read it on the train and later transfer stock quotes to his desktop PC.

Vertical applications for specific businesses. Health care could be the greatest beneficiary of the PDA's advantages, according to Len Steinbach, who's vice president of technology for the National League of Nursing and president of the Microcomputer Managers Association. Unlike expensive terminals, PDAs are portable.

Keep it slim. This may be the biggest challenge as vendors add functionality to PDAs. PDAs must fit easily into a pocket. "I know from my days on Wall Street," says computer consultant David M. Blumenstein, "that the last thing I wanted to do was stuff things into my pocket that were going to kill the design of the suit." —E.P.

Users Say Pen Still Important

Pen-based PDAs have been maligned for their somewhat suspect handwriting recognition. But an informal survey conducted by BYTE shows that many users place a higher priority on PCMCIA, portability, and faxing than on accurate handwriting. The survey results suggest that users value pen-based input, but more for forms-based applications with ink capture than free-form handwriting recognition. (Results are in percentages.)

	Very Important	Somewhat Important	Not Important
Remote file transfer to/from office PC	55	30	15
Auto-synchronization with desktop PC files	41	48	11
Infrared link to desktop	22	56	22
Log on to office network	30	26	44
Send/receive E-mail, files	48	41	11
Send/receive faxes	67	26	7
Cellular voice services	33	30	37
Accurate handwriting recognition	63	26	11
Pen/stylus input	89	7	4
Ability to carry in pocket	85	15	0
Full-size keyboard add-on	7	45	48
Reduced keyboard for two-finger typing	8	33	59
PCMCIA devices	85	4	11
Scaled-down desktop applications	56	33	11
Household management applications	33	37	30
Business-specific (i.e., vertical) applications	19	48	33
Subscription services (e.g., news headlines)	26	33	41
Priced under $500	48	45	7

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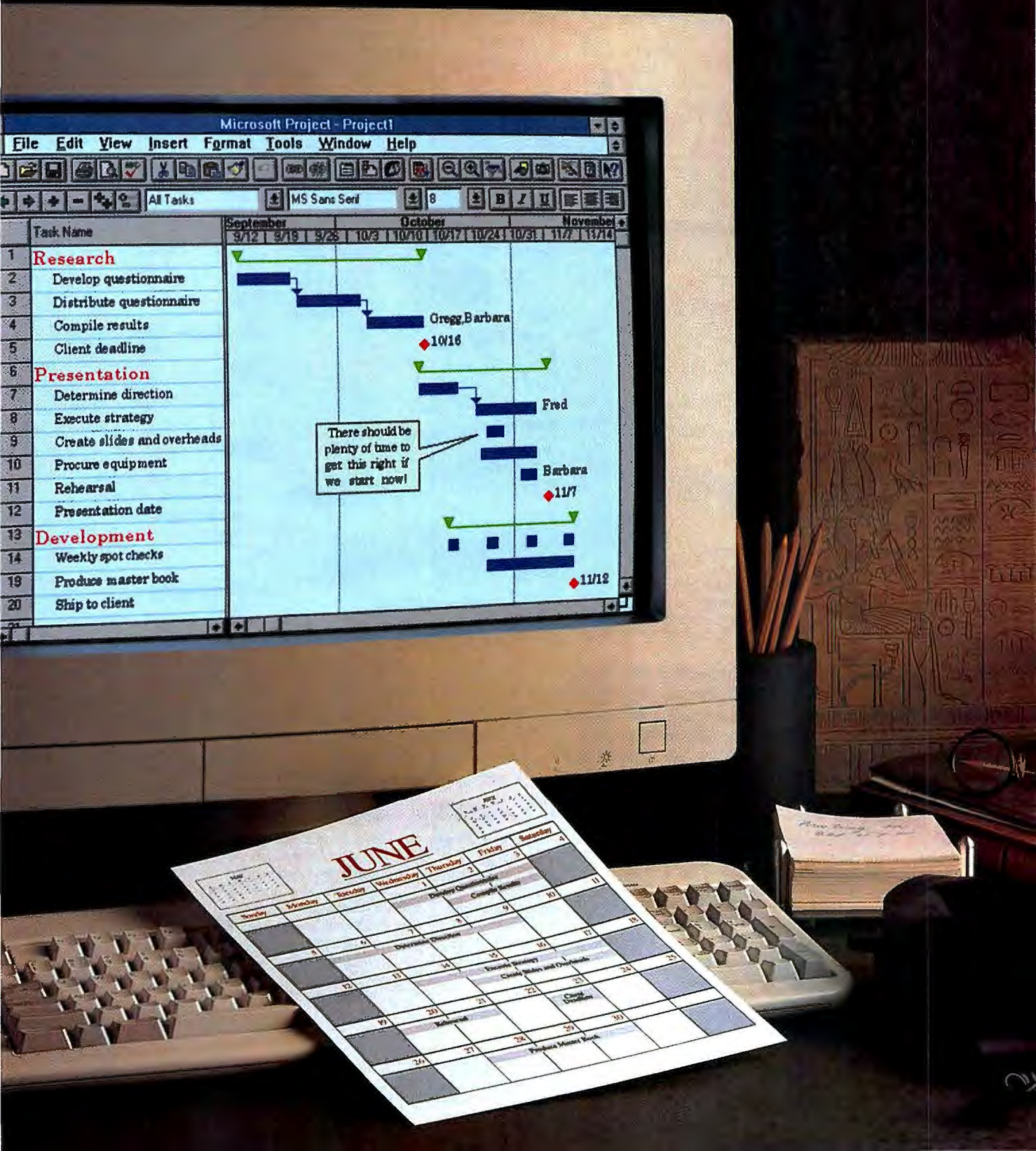
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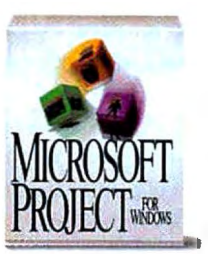
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To do all this (and a lot more) all you have to do is take the first step: Call Microsoft at (800) 671-3955, Dept. KZ5, for more information or for the name of a reseller near you.

You'll wonder how you ever managed without it.

Microsoft

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COURT ACTION

Developers Debate Stac-Microsoft Trade-Secrets Decision

A seven-person jury decided that Microsoft's DoubleSpace disk-compression utility infringes two Stac Electronics data-compression patents and awarded Stac $120 million. The jury also found that Stac had misappropriated and used in Stacker products Microsoft's trade-secret preloading feature and awarded Microsoft $13.7 million.

Software developers and attorneys are debating the ramifications of the second decision. At issue is the preloading program that integrates data compression seamlessly into the internal operations of MS-DOS. Stac says it reverse-engineered the interface between DoubleSpace and MS-DOS and then developed a preload interface of its own for Stacker using a clean-room development process. Microsoft says Stac copied the design and functionality of more than 3000 lines of MS-DOS compression integration code.



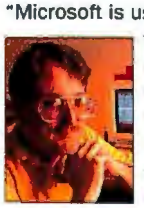
"Stac was attempting to negate the competitive advantage enjoyed by Microsoft's own DoubleSpace developers through their collaboration with the Microsoft MS-DOS developers on this undocumented interface.... When confronted by Stac's patent-infringement lawsuit, Microsoft declared the undocumented interface to be a trade secret and sued Stac over its use. They didn't sue Stac for copyright violation because we didn't copy their code. What we did do was try to level the playing field just a little bit by making Stacker interface to MS-DOS in exactly the same way that DoubleSpace interfaced with MS-DOS."

—Gary Clow, president of Stac Electronics



"Stac disassembled and copied the design, functionality, features, and processes of more than 3000 lines of MS-DOS. This is the reason a federal jury awarded punitive damages against them for violating Microsoft trade secrets, not because they made a few undocumented calls to ensure compatibility. Developers should not be misled by Stac's misrepresentation of facts. Far from going after anyone, Microsoft is more committed than ever to work with the developer community."

—Paul Maritz, senior vice president, systems, Microsoft



"Microsoft is using the Stac case to extend trade-secret protection to algorithms. This is tantamount to banning reverse engineering entirely. Reverse engineering has been a valuable tool in the PC industry. We would not have the PC compatible in the first place if the IBM BIOS had not been reverse-engineered and cloned. Microsoft's attempt to put a stop to this is just another example of how they are trying to dominate this industry. And it's hypocritical...Microsoft's own engineers use reverse engineering, too."

—Tim Farley, author of the forthcoming book *Undocumented NetWare*

CODE TALK

RICK GREHAN

SNIP Away Object Memory Management Chores

In the software nativity wards of the world, new tools are being born daily. Too often, however, it seems the tool you need isn't yet available. This month's development tool is one I wish had been available about two years ago.

Back then, I was working on a rather large database program that required the creation and maintenance of numerous in-memory objects. The program also had many linked lists that wired objects together. The headaches of memory allocation and deallocation were severe enough, without the bookkeeping I had to do to make sure any destroyed object was properly removed from whatever lists it had been placed on.

SNIP (Struct Network Implementation Program) for Windows ($295) from Advantage Software Technologies (Cumberland, RI, (401) 334-4807) would have made my life so much easier I have to fight the urge to lie down and cry. SNIP automates the process of building and maintaining networks of dynamic, in-memory data objects (i.e., objects that can be connected either one-on-one or in arbitrarily complex lists, and that can be created and destroyed).

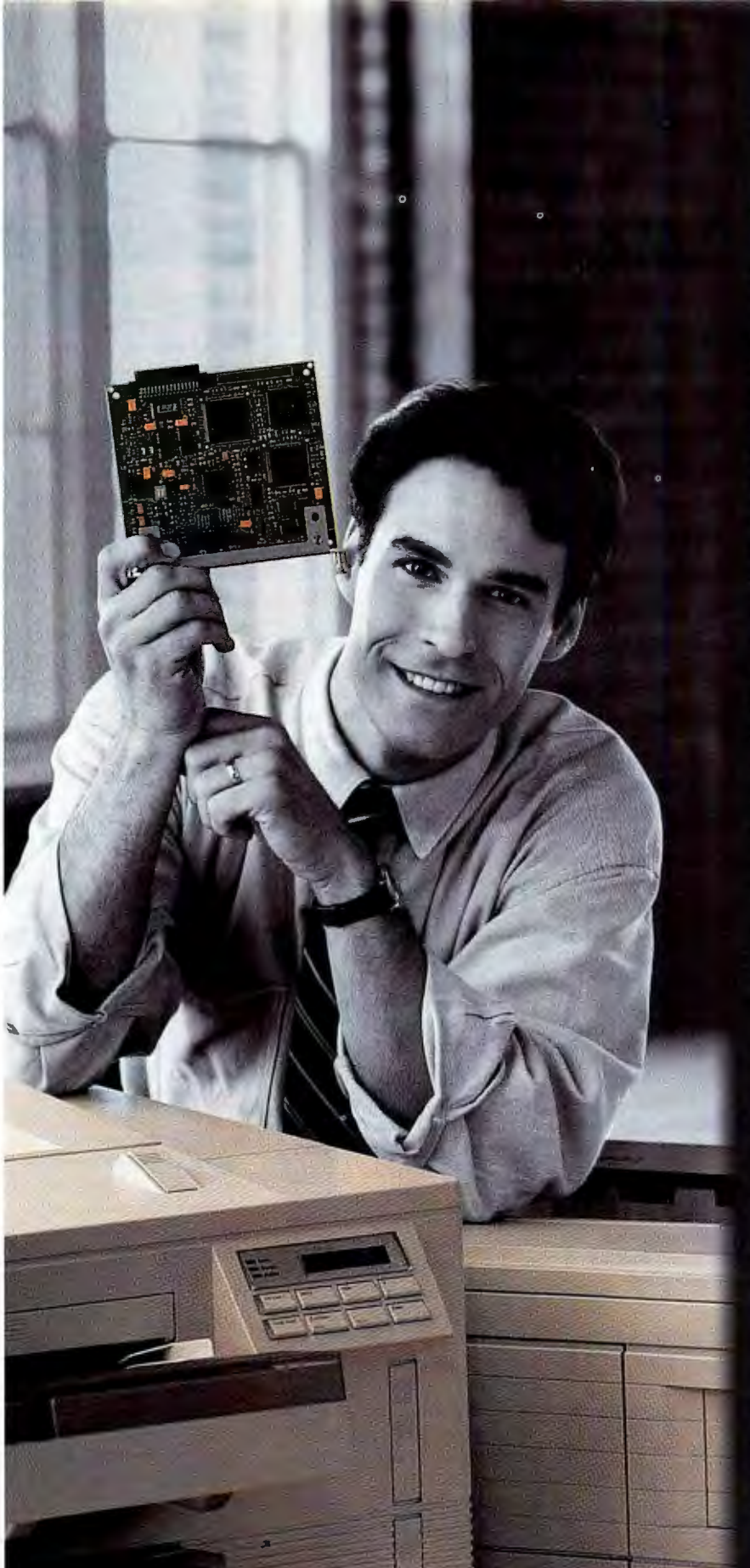
With SNIP, you build a DSM (data structure metafile), which is a file into which you load a definition of your data network, using a structured-language syntax reminiscent of C++ class definitions. The DSM language lets you describe objects as collections of attributes, some of which are descriptive (e.g., a client object consists of an id, which is an int, and the client's name, which is a pointer to a string) and the rest associative (e.g., a department object contains a reference to a list of employee objects).

SNIP then compiles this DSM file and produces C or C++ source code to handle the objects you've defined. It doesn't do everything, mind you, it just takes care of the memory management aspects. For example, if you've asked for C++ code, you'll likely have to edit it to load up the constructors so that data members are properly initialized. You'll also have to merge it into the rest of your application.

What it will build for you, though, are all the methods for creating objects, methods for destroying objects, iterators for walking through lists, methods for linking and unlinking objects to and from lists, and "safe" pointers to reference objects and their contents. (The pointers are "safe" in that they properly return NULL values if the object has been deleted.)

SNIP is positioned just right; it's not so high-level that you can't put application code on top of it, and not so low-level that you can't get underneath it and move its results across platforms. Think of SNIP as sort of a template on steroids. If your application needs lots of linked in-memory data objects, save yourself a lot of time and testing and check out SNIP.





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APPLICATIONS DEVELOPMENT

Options for Notes Developers to Improve

Developers frustrated by a limited number of visual-programming tools for writing client programs that access data stored in Lotus Notes databases should see their options improve this summer, thanks to Lotus Development, Brainstorm Technologies, and even Microsoft. This summer, Lotus plans to release ViP, a Windows-based visual-programming environment to develop graphical front ends for Lotus Notes. ViP, which will sell for $995 per developer, is based on a new version of LotusScript, a structured, BASIC-compatible programming language.

ViP joins a similar program from Brainstorm Technologies (Cambridge, MA, (617) 492-3399) called VB/Link for Lotus Notes ($795). At press time, Microsoft said it was about to begin testing of software that gives applications like Excel bidirectional data-exchange capabilities with Notes.

ViP will help address the concerns of developers who want an easier way to develop custom programs for Notes clients than by using the current applications development environment. ViP distinguishes itself in several areas, in part because it uses a new version of LotusScript that lets a developer construct object classes without having to rely on C++ programming to create custom object classes. Objects developed within LotusScript can be used interchangeably with externally defined objects.

ViP's most dramatic new feature is its linking tool. This tool, which appears in a standard Visual Basic–style toolbox, lets a developer draw a link between any pair of objects, such as a button and a chart tool. As a developer draws the link, ViP generates a default script that specifies how the two objects work together. When the default code does not establish the desired link, developers can sometimes make revisions just by clicking on dialog-box controls. In other cases, simple manual code edits are necessary. ViP should also improve Notes' interaction with SQL databases by allowing the concurrent display of data from multiple sources through Lotus DataLens and support for Microsoft's ODBC (Open Database Connectivity) platform.

Although Lotus says LotusScript is syntax-compatible with Microsoft's Visual Basic, LotusScript and ViP do not support Visual Basic custom controls. Nor does ViP currently let you write programs that view or update data stored in a rich text field in a Notes database. Maria Watts, Lotus's director of product management for applications development products, says a future version of ViP will support rich text fields.

Visual Basic and Visual Basic for Applications cannot currently access Notes databases on their own. But using Visual Basic and VB/Link for Lotus Notes, Visual Basic developers can visually program applications that access information stored in Notes databases. With VB/Link, a developer can compose a response document that can be attached to an existing Notes document, for example. In going the Visual Basic–VB/Link route, you can also take advantage of the many other custom controls available to Visual Basic developers. VB/Link has been shipping since December, and the company plans to release a new version this month that adds support for rich text fields and file attachments in Notes.

—Rick Dobson

LotusScript vs. Visual Basic

Lotus says it will release LotusScript 2.0 this summer. The company will include it in Notes ViP and other applications. Microsoft's Visual Basic for Applications provides users of that company's Office products with a cross-application development language.

Feature	Visual Basic for Applications	LotusScript 3.0
Introduction date	First quarter	February 1993
Products in now	Excel 5, Project 4, Access	Improv 2.1 for Windows
Projected introductions	Word for Windows in 1995	Notes ViP in summer, other products this year; ccMail, SmartSuite, and Notes 4.0 in 1995
Type of programming	Visual Basic technology	BASIC-compatible with object-oriented extensions
When it will support OLE Custom Controls	Now in Access 2.0, future Microsoft applications	Early 1995
Platforms	Windows, Mac	Windows, OS/2, some Unix



Intergraph's port of Windows NT to the Clipper RISC processor (see "Windows, Windows Everywhere?," June 1993 BYTE)

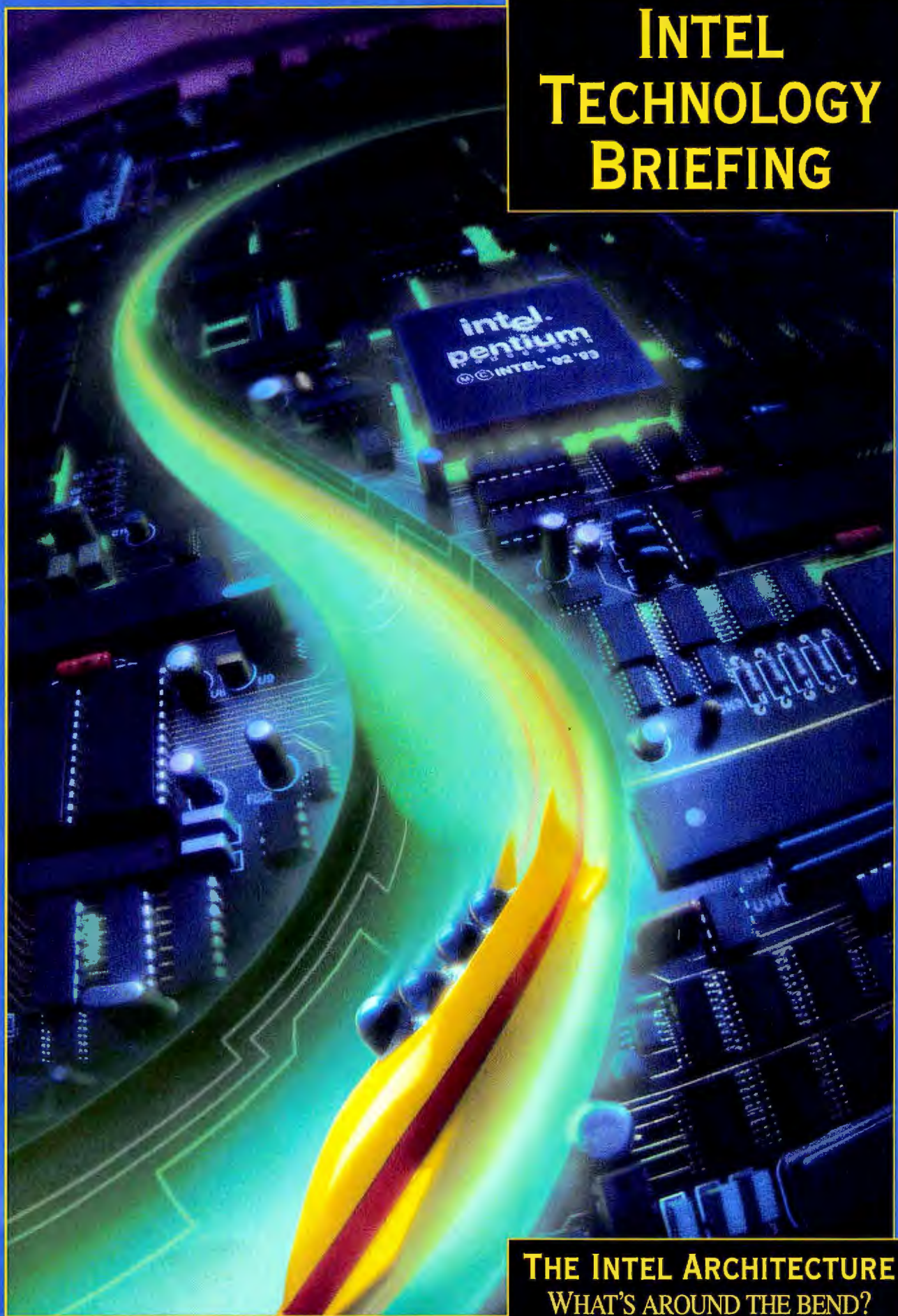
Intergraph (Huntsville, AL, (205) 730-2000) has canceled that effort and is currently porting its wide range of CAD applications to Windows NT running on Intel-based processors. "Intergraph is now offering customers a move to the Windows NT Pentium environment," says Bill Payne, manager of systems product marketing at Intergraph. Payne added that earlier this year, engineers that had been helping Sun Microsystems port Windows NT to UltraSparc left Intergraph and now work at Sun. —D.A.

The U.S. Government's plan to deliver encryption hardware with a trapdoor for police eavesdropping (see "Encryption Chip Draws Fire," July 1993 BYTE)

The plan continues to meet broad and stiff resistance from public-interest groups and industry coalitions. The Computer Professionals for Social Responsibility (Palo Alto, CA) sponsored a petition that people could sign by sending in E-mail and received 48,000 signatures at the time this was written. Opponents say the Escrowed Encryption Standard suffers from being expensive, intrusive, and of uncertain value. The FBI and National Security Agency back the plan because they believe court-approved eavesdropping is necessary for investigating certain crimes.To obtain the petition, send a blank message via E-mail to petition-info@cpsr.org.

—Peter Wayner

Intel Technology Briefing



The Intel Architecture

What's Around the Bend?

THE NEXT GENERATION OF PROCESSORS. COMING IN RECORD TIME.

During the past 15 years, Intel has introduced five generations of processors. So what's next? This technology briefing will discuss how Intel is delivering faster processors with less time between generations by combining the Intel Architecture with innovative design and manufacturing techniques. We'll even look at our new processor, code named "P6," available in 1995.

A FOUNDATION TO BUILD ON.

From the 8088 processor through the new "P6" processor, one thing has remained compatible—the Intel Architecture. But what is it?



When most people think of architecture, they think of different styles of buildings. An architect would give builders different "instructions" for constructing a Victorian-style building than a Gothic-style building.

Microprocessor architecture is similar. Intel is like the architect. We give software developers a set of instructions for writing programs. The Intel "style" of instructions, registers and memory management has remained consistent across generations. Which means the many programs already written for the Intel Architecture will be upwardly compatible with the new "P6" processor.

BETTER DESIGN. FASTER PROCESSORS.

In order to maintain compatibility while increasing performance, Intel must constantly develop new design techniques. We don't change the "rules" of the Intel Architecture. Instead, we make it run more efficiently.

For example, we gave the Pentium™ processor multiple pipelines for simultaneous instruction execution. In addition, we gave it 64-bit data paths, separate 8 Kb data and code caches, and a branch prediction unit to keep information flowing into the processor as quickly as possible. And we're continuing to improve the Pentium processor, which will run at clock speeds of up to 150 MHz in the next version. The "P6" processor will incorporate even more sophisticated techniques to execute instructions at over 250 MIPS.

CAN YOU BUILD IT?

Even the best design ideas are useless without the ability to economically implement them on-chip. That's why Intel expects to invest $3.5 billion this year alone in R&D and equipment—substantially more than any other semiconductor manufacturer. By predicting the manufacturing technology available years from now, we can plan today which design techniques will be possible for use in tomorrow's processors.

By developing new manufacturing processes, we are able to fit more and more transistors into smaller and smaller spaces. Not only does this allow us to add new capabilities to each new generation of Intel processors, it allows us to shrink the processors within each generation—resulting in faster performance and lower-power chips such as the 100 MHz, 3.3-volt Pentium processor.

What's more, Intel's manufacturing capacities enable us to produce tens of millions of processors every year. Enough to fill the demand as computers move into more and more households.

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64-BIT DATA BUS, BRANCH PREDICTION

INTEL486™ PROCESSOR
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ON-CHIP CACHE, FLOATING POINT UNIT

INTEL386™ PROCESSOR
275,000 TRANSISTORS, 1.5 MICRON
32-BIT INSTRUCTION, REGISTER AND DATA BUSES

THE INTEL ARCHITEC

THE INTEL ARCHITECTURE—A SET OF INSTRUCTIONS OR "RULES" OF OPERATION—HAS BEEN SIGNIFICANTLY ENHANCED SINCE ITS 16-BIT ORIGINS IN THE 8088 AND 80286, WITHOUT LOSING ITS SOFTWARE COMPATIBILITY. ALTHOUGH

DESIGN TECHNIQU

REGARDLESS OF A PROCESSOR'S ARCHITECTURE, DESIGNERS MUST CONSTANTLY FIND WAYS TO MAKE IT MORE EFFICIENT. WE DO THIS WITH INTEL PROCESSORS BY PERFORMING TASKS IN PARALLEL AND KEEPING DATA

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INTEL PROCESSOR ROADMAP

TURE

NEWER INTEL PROCESSORS ARE CAPABLE OF RUNNING TODAY'S 16-BIT SOFTWARE FASTER AND MORE EFFICIENTLY, THEY ARE OPTIMIZED TO RUN NEWER, MORE SOPHISTICATED 32-BIT SOFTWARE. PLUS, VIRTUAL MEMORY MANAGEMENT TECHNIQUES ENABLE THE INTEL ARCHITECTURE TO ADDRESS UP TO FOUR GIGABYTES OF MEMORY. SO IT SUPPORTS THE DEMANDS OF NEXT-GENERATION APPLICATIONS AND OPERATING SYSTEMS.

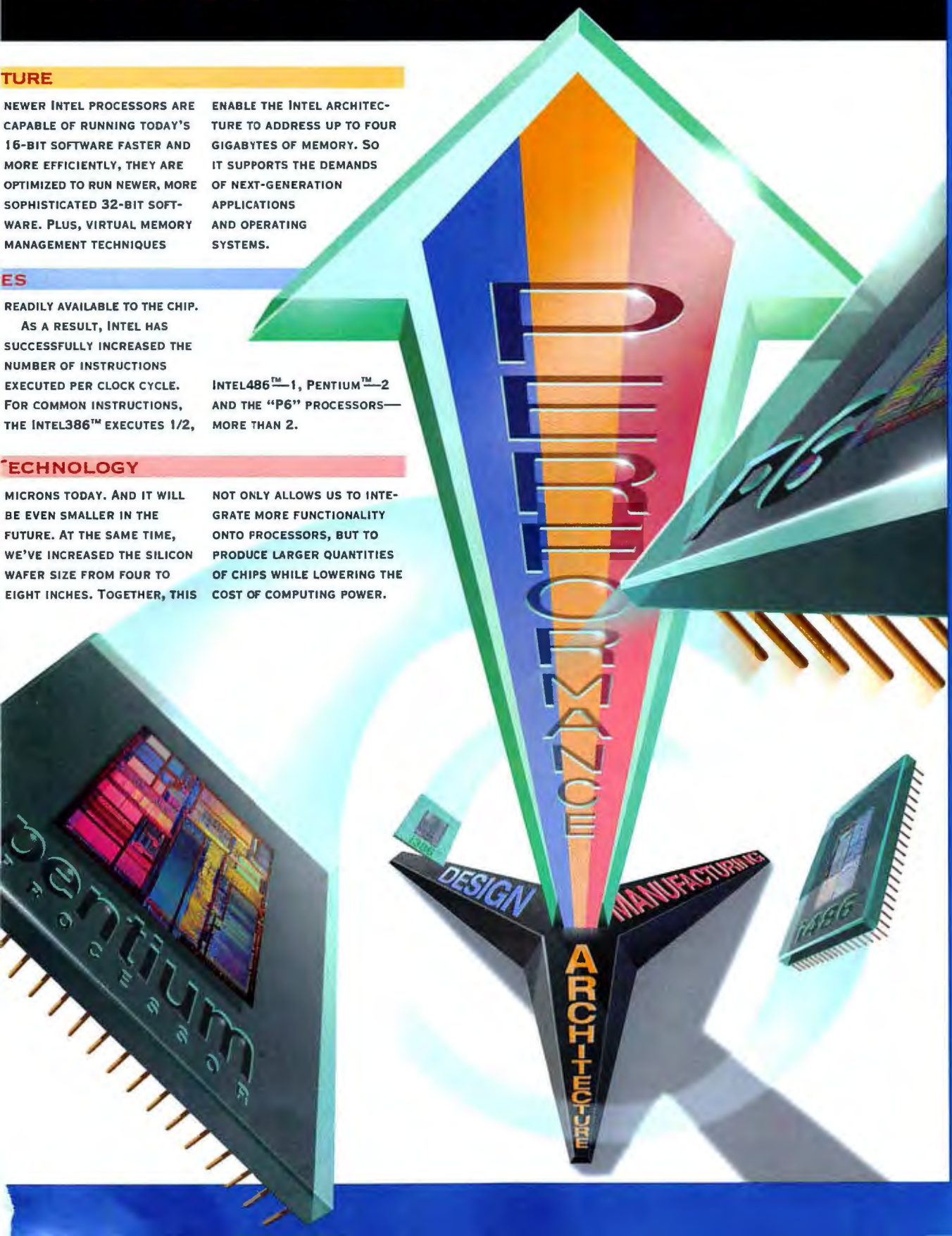
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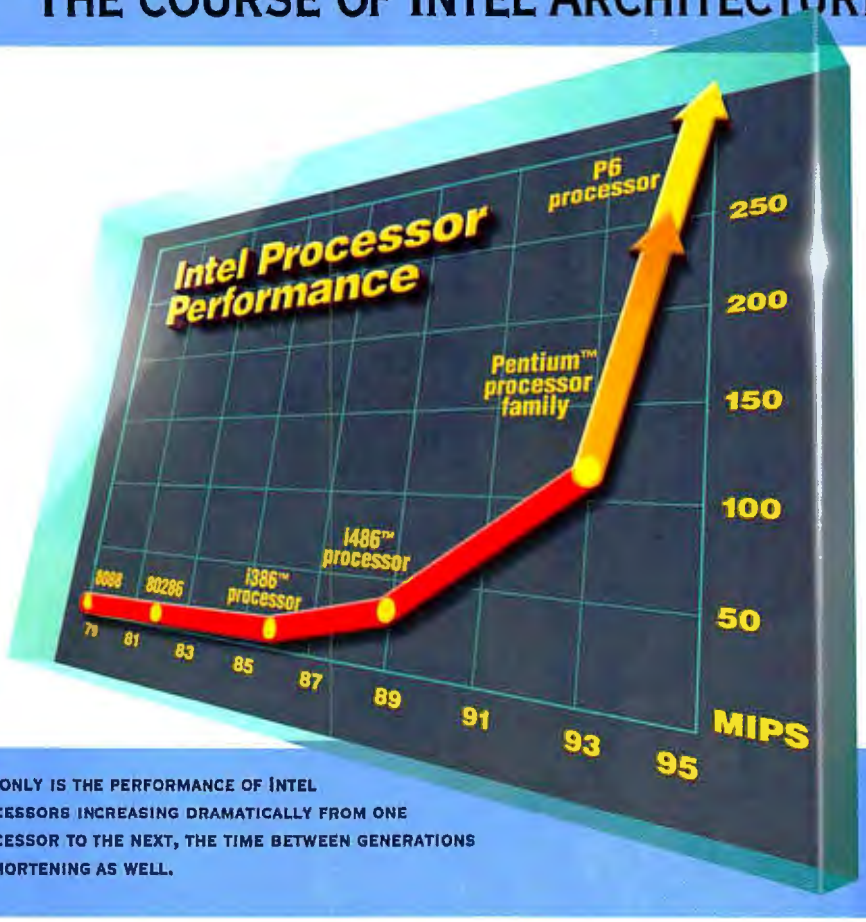
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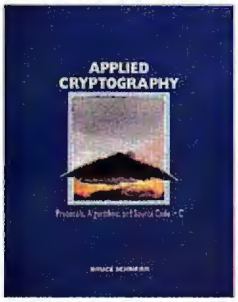
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Levels of Secrecy



RICK GREHAN

The opening sentence in the preface of *Applied Cryptography* says it all—I have to quote it: "There are two kinds of cryptography in this world: cryptography that will stop your kid sister from reading your files, and cryptography that will stop major governments from reading your files. This book is about the latter."

You can use *Applied Cryptography* for more than one purpose. You can read it as an introduction to the mathematics of cryptography, as a resource of source code for cryptographic algorithms, or as a guide to how traffic on the information superhighway might remain secure even as the highway (supposedly) becomes more accessible.

Cryptography isn't restricted to studying the means by which a digital document is securely encoded for purposes of transmission. It can cover activities as well—activities once carried out via the transfer of paperwork, but now carried out by transactions across a network. Take digital signatures, for example. Bank A sends a transaction to bank B. The transaction is encoded, of course. But how can the clerk at bank B be sure that the transaction was authorized by the proper officer at bank A prior to being encoded and transmitted?

This is one of the topics of perhaps my favorite section of the book: cryptographic protocols. It begins with fundamentals (e.g., authentication and public-key cryptography), builds through intermediate protocols (e.g., digital signatures and subliminal channels), and moves to advanced protocols (e.g., blind signatures). The best material, however, appears in the concluding topic: esoteric protocols. Here, you'll find step-by-step procedures for such operations as secure elections and digital cash.

Some of the protocols read like descriptions of Rube Goldberg machines. I followed in fascination the step-by-step process that Alice (a hypothetical character) could use to accomplish the audit-trail-free transfer of digital cash. Alice could send a campaign contribution to her favorite senator, and no one could trace where the money had come from. And it gets worse: Alice shows up pages later using digital cash to commit a perfect kidnapping.

It also gets better. In a later chapter, we're given a brief glimpse of—no kidding—"quantum cryptography." All it takes is some polarized light and a fiber-optic link; the message is encoded in the polarization angle of the light. What you get is an untappable link—since tapping would require measuring a quantum variable, which affects the outcome of any subsequent measurements. Sender and receiver can compare partial messages and verify the presence or absence of an eavesdropper.

Finally, if you want code, you've got it. Not only are code fragments smattered throughout, the rear of the book contains listing after well-documented listing (all in C) of cipher routines, secure hash functions, and so forth. If you want to avoid typist's cramp, you can send $30 to the author and get the disk set that includes all the source code from the book, plus updates and new algorithms. If you're not a programmer, don't let the presence of so much source code frighten you. The descriptions of the exchange protocols—intricate though they may be—make good reading for anyone interested in cryptography. ■

APPLIED CRYPTOGRAPHY: PROTOCOLS, ALGORITHMS, AND SOURCE CODE IN C

Bruce Schneier
John Wiley & Sons
ISBN 0-471-59756-2

$44.95

Rick Grehan is technical director of the BYTE Lab. Before coming to BYTE, he worked as a programmer. He has a B.S. in physics and applied mathematics and an M.S. in mathematics/computer science. You can reach him on the Internet or BIX at rick_g@bix.com.



MINSKY GOES MULTIMEDIA

FIRST PERSON: MARVIN MINSKY, THE SOCIETY OF MIND The Voyager Co., 578 Broadway, Suite 406, New York, NY 10012, (212) 431-5199, $49.95

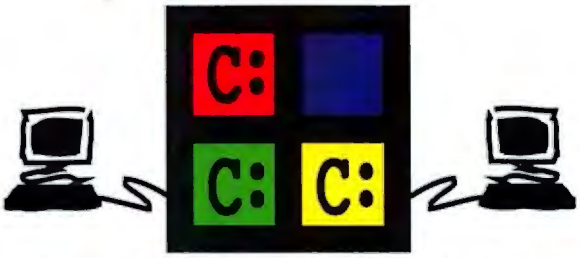
The Voyager Co., a pioneer in moving printed media to electronic media, serves up a new CD-ROM title, First Person: Marvin Minsky, The Society of Mind. The disc contains the complete text of Minsky's *The Society of Mind*. This work attempts to explain just how the mind works. In it, Minsky proposes how nonthinking matter gets to the point where it can reason, comprehend the world, and ultimately consider itself. His theory is that thought involves small agents or processes that manage small tasks. These agents, operating as a collective society, combine synergistically to form consciousness.

The CD-ROM improves on the book in several ways. The original illustrations were updated and redrawn in color, and the text has hypertext links to an extensive glossary and bibliography. The material is leavened with animations and QuickTime movies—whose subjects range from Minsky explaining theories on thought to a tour of his living room—that make an interesting subject matter entertaining.

The one problem that I had with the interface was locating Voyager's standard Tool palette, which allows you to easily navigate through the pages and return from the glossary. (It's in the Books menu. This menu is normally not visible. However, if you're familiar with the Voyager products, this isn't a problem.)

Given the room a CD-ROM offers and Voyager's grasp of the technology, I'm just a little disappointed that Minsky didn't take the extra step of expanding the subject matter. Once you get past the embellishments, there's not much beyond the original material on the disc. If you're intrigued by Minsky's theories, the CD-ROM presents them in new and interesting ways. If you disagree with his ideas, there's nothing new to convince you otherwise.

—Tom Thompson



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SEEKING THE GRAIL

PLUG & PLAY PROGRAMMING: AN OBJECT-ORIENTED CONSTRUCTION KIT by William Wong M&T Books, ISBN 1-55851-302-7, $39.95 (with disk)



Programming fads come and go, but the search for the Holy Grail of productivity, reusability, and simplicity continues unabated. *Plug & Play Programming: An Object-Oriented Construction Kit* by William Wong brings us one giant step closer to the goal. It moves beyond the theory that object-oriented languages like C++ provide the ability to generate reusable code into the practical realm of real-world technique.

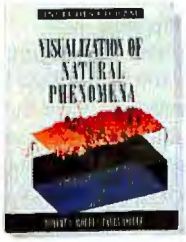
The basic premise is simple. Why shouldn't programming, at some level, be as simple as hooking up your stereo system or, at a lower level, designing an electronic circuit by connecting standard parts. The missing ingredient in software design is standardized connections.

Wong addresses this problem by creating a standard object interconnection: the plug. Plugs (and their analogous sockets) allow objects to be connected in a consistent manner that leads to code that is more readable, understandable, and flexible.

Plug & Play includes a detailed examination of the source code that is available on the accompanying IBM disk. The code is usable by any ANSI C++ compiler. You can also use plugs with other object-oriented languages, and the book has a chapter on Smalltalk and Borland Pascal with Objects.

Using plugs and sockets is not a panacea that will magically make programming simpler, as the author himself recognizes. Wong describes this programming technique as "just another tool," although it's a powerful one that will shape the way you design your applications.

—Raymond GA Côté



VISUALIZING DATA

VISUALIZATION OF NATURAL PHENOMENA by Robert S. Wolff and Larry Yaeger Springer-Verlag, ISBN 0-387-97809-7, $59.95

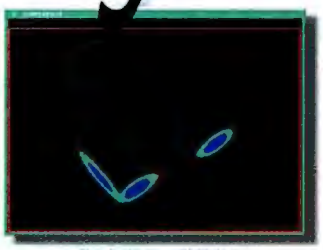
With its large format and classy production, this 374-page volume might be mistaken for a coffee-table book. But *Visualization of Natural Phenomena* is not for the browser interested in slick images; rather, it's for scientists, mathematicians, and engineers who are ready to learn more about the benefits of visualization.

The book includes a CD-ROM (in Macintosh HFS format) and is organized around applications (e.g., imaging numbers and visualization of multivariate systems). While the CD provides you with real-world examples of on-screen images and animation (some with sound), the low-resolution displays only hint at the character and quality of images found on true scientific-visualization workstations. ■

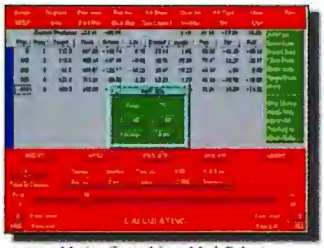
—Scott Wallace

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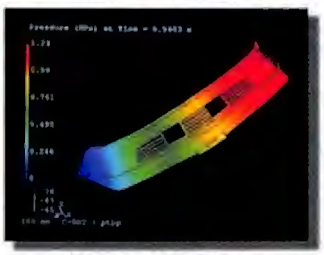
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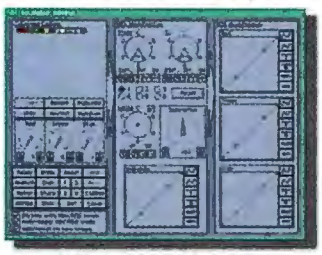
MOSS from Moss Systems Limited



Voltacad & CADIBA from IB COM Software AG™



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XV (Shareware) from John Bradley



XCad Designer from Digital Multimedia Limited

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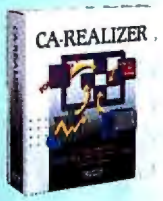
ProtoGen+ Client/Server Suite
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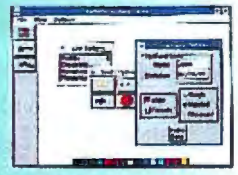
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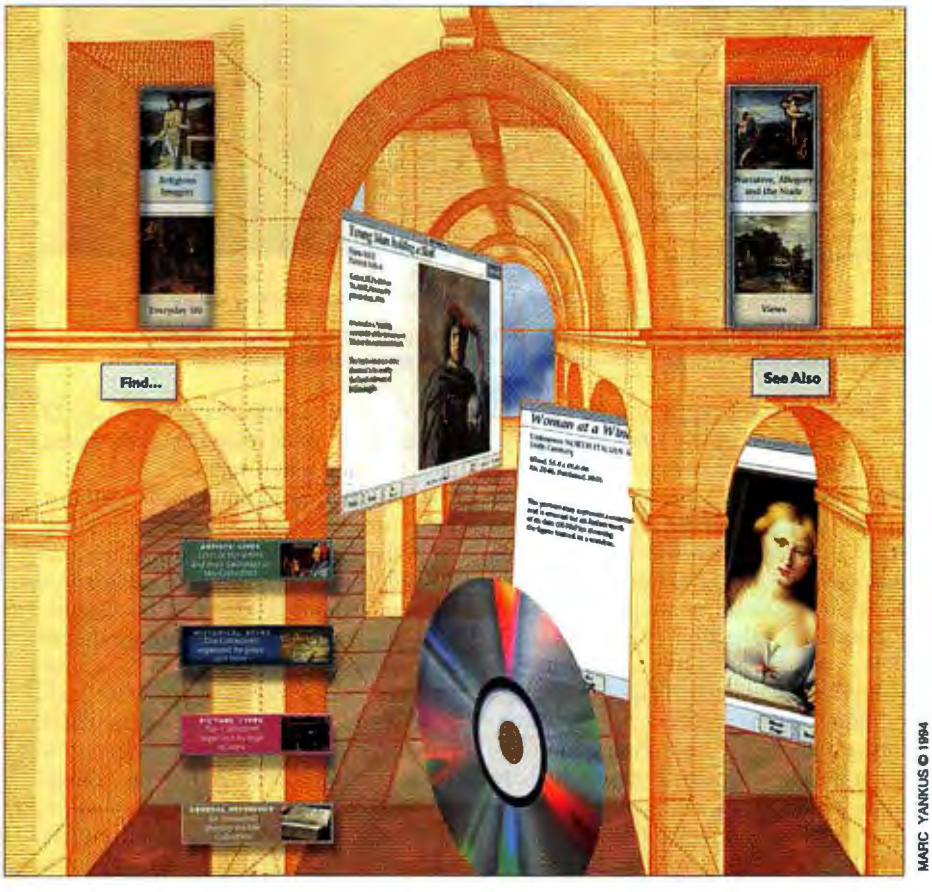
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The Fine Art of CD-ROM Publishing

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MARC YANKUS © 1994

Until recently, I'd been distinctly unimpressed by the quality of CD-ROMs, and I was beginning to think that the good old printed book was safe for another century. All it took to change my mind was Microsoft's new Art Gallery CD-ROM, which reproduces all 2200 paintings from the National Gallery in London.

The quality of the illustrations in Art Gallery is excellent—even on a humble SVGA display—and its hypertext user interface enables you to browse and make connections in ways that an art book simply can't match. As well as indexing the whole collection by name, subject matter, time, and geography, Art Gallery employs ingenious animations to explain painting techniques, compositional devices, color schemes, and symbolism that the painters used. It is like visiting the gallery with a team of art historians at your elbow, which is not surprising since the National Gallery's experts were intimately involved in designing Art Gallery.

Microsoft's Art Gallery demonstrates how materials normally presented in traditional media can successfully migrate to electronic publishing

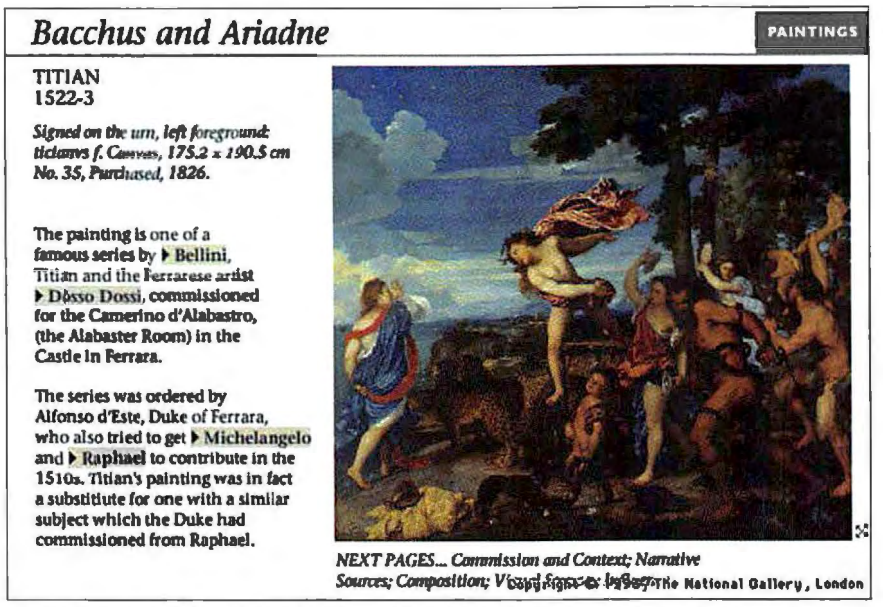
Virtual Visits

A CD-ROM is no substitute for standing before the original paintings, but it can prepare you so that you know what you're looking for when you do visit a gallery. The fact that I live in London and regularly visit the National Gallery probably colors my enthusiasm for Art Gallery a little, but Microsoft has plans to produce similar CD-ROMs for other great art collections, and I hope it will use the same excellent user interface for them all.

I look forward to the day when I can have all the world's great paintings at my fingertips in a single bookshelf of CD-ROMs. In addition, I look forward to the day when all publishers follow the lead of the National Gallery in examining beforehand how material can best be transported and displayed in electronic format. This is the secret to successful electronic publishing.

The Micro Gallery

Microsoft's Art Gallery CD-ROM is directly derived from an interactive online system called Micro Gallery, which is available free of charge to the public in the National Gallery's new Sainsbury Wing in Trafalgar Square. This new building, the first major extension to the gallery in 50 years, holds the gallery's early Renaissance collection. The Micro Gallery, which the American Express Foundation paid for with a $1,000,000 sponsorship, is a long thin room just off the ground-floor entrance, which holds a network of 12 keyboard-less Macintosh workstations that are built flush to the wall and fitted with 19-inch touch-sensitive screens. Visitors have free access to the Micro Gallery to browse the gallery's collection. For a small fee, you can make black-and-white prints of particular paintings or print a personalized map showing the locations of a desired list of paintings. *continued*



The Art Gallery uses subdued shading in its text to indicate links to animations and other information. The copyright notice does not appear on-screen, but is imprinted in files captured from the CD-ROM.

The National Gallery was founded in 1824 to hold the U.K.'s national collection of western European paintings. It contains about 2200 works from over 700 artists, dating from the thirteenth to the early twentieth centuries and includes many major works of Rembrandt, Rubens, Titian, and Poussin, as well as a fine early Renaissance collection.

It is not perhaps the collection you would have expected to pioneer computerization—some high-tech twentieth-century gallery like Paris's Pompidou Center or the Getty would seem superficially to be a more likely candidate. A precondition of the National Gallery's success was the fact that its collection, while of outstandingly high quality, is relatively small, and almost all its pictures are on public display rather than in storage. This meant that a complete interactive catalog was feasible using personal computer technology from the late 1980s; however, museums with much larger collections would have to choose between using expensive mainframe systems or cataloging only parts of their collections. Even so a forward-looking management and a generous sponsor were vital in realizing the opportunity.

The gallery appointed an internal project manager who, in turn, recruited an outside software house, Cognitive Applications of Brighton, U.K., to create the necessary software. Graduates of the AI department of the nearby University of Sussex started this firm in 1985 and acquired special expertise in Macintosh programming and in designing interactive user interfaces. A team of up to 10 people from the gallery and Cognitive Applications put in 23 worker-years of development time spread over two-and-a-half years.

The design team quickly decided that the most important goal would be a fast response time, which would allow untrained visitors to browse the catalog in a spontaneous and relaxed fashion. Quantified, this meant that each painting should be retrieved in 1 second or less. Given the limits of 1989 personal computer technology, this decision more or less determined the technical approach. Analog video storage had already been ruled out on grounds of poor visual quality, but having chosen to go digital, there was then no affordable network technology that would support an acceptable client/server implementation (if starting today, you might consider an ATM [Asynchronous Transfer Mode] network over optic fiber). Optical disk storage was also too slow.

Only magnetic storage could handle the job, so Micro Gallery was designed around Mac IIfx workstations (the fastest Mac then available). Each workstation contained a copy of the entire picture database on its local 1.3-GB hard drive. An Appletalk LAN is used outside public hours to perform maintenance updates only; it is not for interactive retrieval. This distributed storage scheme has the added advantage of being very robust; when one workstation goes down, it does not affect the others.

For displays, the team chose 19-inch Radius touchscreen monitors with an extra fine dot pitch of 82 dpi (compared to the normal Mac 72 dpi) and a refresh rate higher than 70 Hz. To further enhance the appearance of these screens, all the text is antialiased in software.

The Micro Gallery catalog is a large publication of some 4500 pages with 300,000 words of text and 12,000 color illustrations; therefore, fitting it all onto even a 1.3-GB disk required further radical design decisions. To achieve acceptable picture quality, you might assume that the illustrations would have to be in 24-bit true color, but Cognitive Applications made no such assumption. Instead, it experimented with display depths of 24, 16, and 8 bits and discovered that 24-bit images were so large as to require hardware-assisted compression, and even then, the required response times could not be met.

Finally, the team bravely decided to go with 8-bit images, employing special palette optimization techniques to achieve adequate image quality. The strategy was spectacularly successful, and even technically knowledgeable people who visit the Micro Gallery have great trouble believing the displays are not 24-bit. Plumping for 8-bit images also paved the way for Microsoft to turn Micro Gallery into the Art Gallery CD-ROM; only a few high-end Mac users and fewer PC users have 24-bit display hardware, so using 8-bit format opened up Art Gallery for the rest of us.

The Macintosh and Windows versions of Art Gallery contain almost exactly the same software used in the Micro Gallery, reduced in resolution from 1152 by 882 pixels to 640 by 480 pixels, which the less-expensive Macs and SVGA PCs can handle, and, of course, a mouse replaces touchscreen controls. If you try to run Art Gallery on a video adapter that doesn't support 256 colors, it warns you that the results will not be acceptable but will try it anyway; thus, you can even run it on a monochrome PowerBook. The Macintosh version of Art Gallery retains the antialiased body text, but the PC version had to drop this feature, as Windows doesn't properly support multibit fonts.

Acquiring the Data

The Micro Gallery project and National Gallery CD-ROM benefited from some ongoing work at the National Gallery. In this regard, they are excellent examples of how the new media can leverage off the old. The National Gallery's photographic department already had a rolling program for photographing the complete collection onto 10- by 8-inch color transparencies, and in 1986, the National Gallery had produced a written catalog using computer typesetting. Both of these projects helped the Micro Gallery get off to a flying start. A handful of the less important pictures have only been photographed in black and

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white and appear as such in the Micro Gallery and the Art Gallery. Also, some pictures had been photographed in less-than-ideal conditions (e.g., tungsten light), and the team used Adobe Photoshop to color-correct these images manually.

It took two years to scan all the transparencies on a Sharp JX-600, for which Cognitive Applications had to write custom scanner drivers to achieve the desired results. A strategic decision was made to scan everything at 24 bits so that scanning could begin before the final display depth was decided, and thus the scans could be reused if a 24-bit version was needed in the future. This demanded vast storage space, which was met in the early days by Syquest cartridges and later by erasable optical drives.

Most pictures in the Micro/Art Gallery appear at three different sizes: first as an 80- by 80-pixel thumbnail used in menu selections, then in position on the page, and finally zoomed to full-screen height. Run-time software enlargement from a single 8-bit master degrades the image quality too much, so three separate 8-bit bit maps are dithered down from each 24-bit master and stored in the run-time system.

Cognitive Applications evaluated various image-compression schemes, including the fractal compression scheme from Iterated Systems that Microsoft uses in its Encarta. The conclusion was that dithering to 8 bits is in itself the most effective and fastest compression for this particular material. Fractal compression of the 24-bit scans achieved a 3-to-1 compression ratio (as did going from 24 to 8 bits), but fractal images took longer to decompress and fractal compression lost more fine detail from the paintings. RLE (run-length encoding) schemes were ineffective in further compressing the dithered 8-bit images, which look pretty much like random bit streams to an RLE algorithm.

Optimizing the Palette

The excellent picture quality in the Micro/Art Gallery is entirely dependent on the choice of an optimal color mapping. Both Macintosh and PC SVGA 8-bit video adapters support 256-color display modes in which a CLUT (color lookup table) or palette holds the 256 current display colors chosen from some much larger color space (18 bits or around 250,000 colors for SVGA adapters). In practice, both the Macintosh and Windows operating systems reserve 16 or so colors for GUI purposes so that only around 240 colors are really selectable. Thus, the challenge is to choose exactly those 240 colors that will represent a particular painting or group of paintings as effectively as possible.

This task was made a little easier due to the National Gallery's collection containing mostly oil paintings over 100 years old, which use a more limited gamut of colors than is used today or even in early twentieth-century paintings. Finding the best palette involved a mix of computer and manual methods. Cognitive Applications wrote a program (see the text box "The Palette Optimization Algorithm") that analyzed a particular 24-bit scan and extracted a 256-color palette that distributed the color content of the picture as evenly as possible in a mathematical sense. In 1990, this was still fairly esoteric stuff, but nowadays, commercial tools like Adobe Photoshop include this capability, and indeed Cognitive Applications itself now uses Adobe Photoshop and DeBabelizer from Equilibrium Technology to extract palettes.

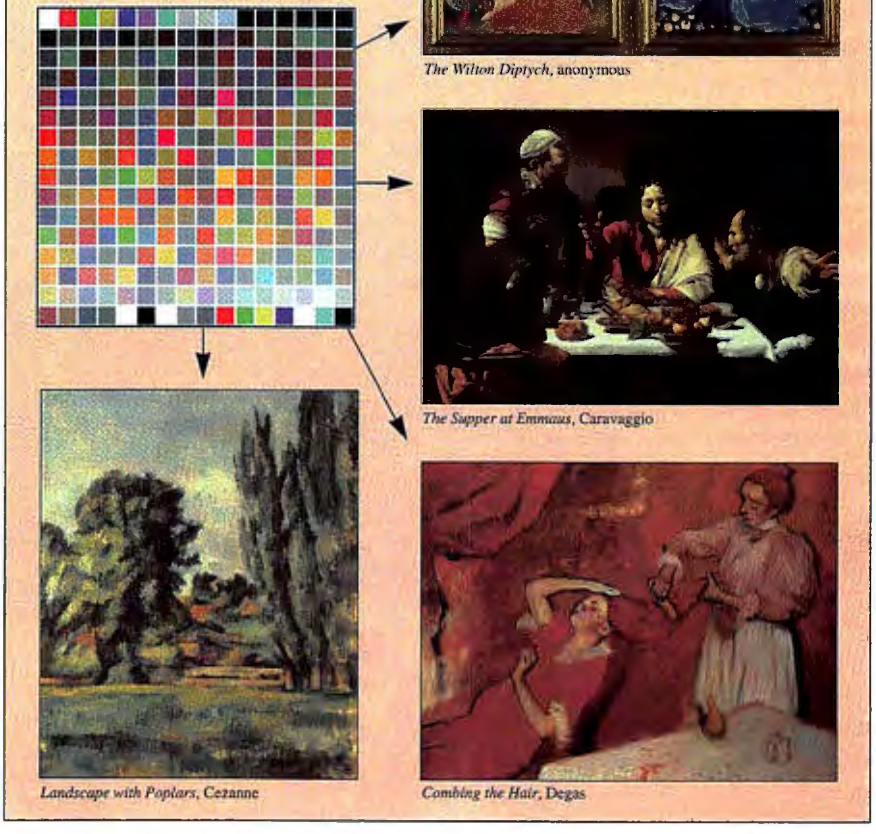
For the first Micro Gallery prototypes, the team tried to use a separate customized palette for each picture, but the adoption of menu pages containing several thumbnails made this impractical. Then the team tried one palette per page, but this still caused unsightly and disconcerting screen artifacts when turning from one page to another, and a solution using a special transition palette of neutral colors was only partly effective. It became clear that a single palette would have to work for the whole collection (see the figure "One Palette Fits All").

All 2200 scans were run through the color-mapping program and combined to yield a single 240-color palette. The National Gallery curators then reviewed the paintings as they appeared in this palette and suggested manual adjustments to the final mapping. This was a necessary step, because while a computer program can achieve a mathematically optimum mapping, it doesn't take any account of the subject matter and meaning of the paintings or of human aesthetic preferences.

continued

One Palette Fits All

The decision to use a single palette across the collection made choosing the palette decisive in the success of the publishing effort. After the computers were finished, experts from the National Gallery tweaked the palette so that it worked across the range of styles represented by the collection.



The Wilton Diptych, anonymous

The Supper at Emmaus, Caravaggio

Landscape with Poplars, Cezanne

Combing the Hair, Degas

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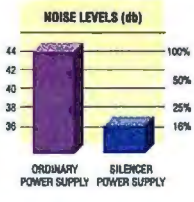
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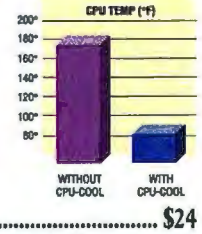
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For example, given a Bellini *Virgin and Child*, the program might correctly allocate as many shades of blue for the Virgin's cloak as flesh tones for the faces. But a human expert regards the faces as more important than the cloak and would like to dedicate more palette space to flesh tones, to achieve better modeling of faces and limbs without visible tone steps. Similar arguments might be made for the greens in landscapes, to which the human eye is particularly sensitive.

The final palette derived for the Micro/Art Gallery is enriched in flesh, green, and brown tones and relatively depleted in primary colors. If you were to use the same procedure to scan a collection of twentieth-century abstract paintings by Kandinsky, Rothko, and other artists, you might arrive at a completely different palette.

The Art Book that Moves

The most significant advantage that a computer screen offers over an art book is the possibility of moving the images, and the Micro/Art Gallery project exploits this advantage by using animation to illustrate features of the paintings; another reason to be thankful for those 8-bit images.

Many of the animations simply consist of "draining" color from the painting to a monochrome image and then selectively reintroducing color to highlight certain groups of figures and compositional blocks. Another trick is to superimpose text labels that explain the symbolism of various objects in a picture. To illustrate perspective theories, you can overlay converging lines and grids or planes that cut up the picture space.

Other animations explore the way pictures were produced (e.g., by superimposing an x-ray view over the paint to reveal earlier work underneath). A Bellini fresco is dissected into the successive layers of applied paint, while a portrait of the duke of Wellington sprouts the extra medals Goya added at the end of the Peninsular War. Perhaps the most ambitious animation is for Vermeer's *Young Woman Standing at a Virginal*. To illustrate the accuracy of Vermeer's perspective (he may have used a camera obscura), Art Gallery constructs a 3-D model from the painting and then flies through three different views of the room.

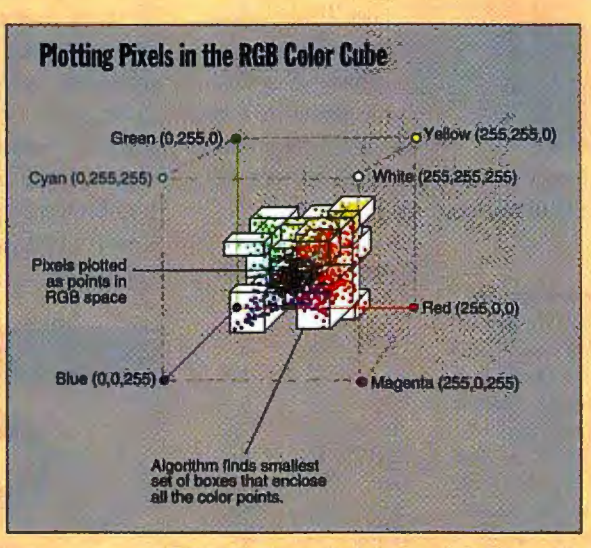
Some important paintings (e.g., Titian's *Bacchus and Ariadne* or Poussin's *Adoration of the Golden Calf*) warrant three or more animations dealing with composition, narrative, and construction methods. One animation that makes me smile is for the *Adoration of the Golden Calf*. It demonstrates that Poussin cribbed a group of figures from one of his own earlier paintings by simply flying the group from the earlier picture to the later while flipping it 180° horizontally.

Invitation to Users

According to Cognitive Applications' director, Ben Rubenstein, the guiding principle in the design of Micro Gallery's user interface was "to make it more like a book than a screen." Many people still have a phobia about computers, and people who regularly visit art galleries might be expected to be less at ease with computers than the average. The result of following this principle is a roaring success judged from the overwhelmingly favorable comments

The Palette-Optimization Algorithm

The program that Cognitive Applications wrote to extract optimum 8-bit color mappings from 24-bit scans of paintings employed a published algorithm by Hekbert, while commercial products like Adobe Photoshop use closely related algorithms. The algorithm is topological in nature, working on the proximity of colors in a 3-D color space.



First, you must resolve all the 24-bit pixels that make up a single scan (around 300,000 of them in the case of a 640- by 480-pixel image) into their 8-bit RGB components. You can then plot each pixel to a color point in the 3-D 24-bit RGB color cube, as shown in the figure "Plotting Pixels in the RGB Color Cube."

Now sort the R, G, and B components to determine their maximum and minimum values and use these limits to "shrink" the color cube down to the smallest rectangular box in RGB space that will contain all the pixels.

You split this box into two smaller boxes along its longest axis and repeat the shrinking process on these smaller boxes. The main loop of the algorithm repeats this process of choosing a box to split, splitting it, and then shrinking the fragments, adding one new box at each iteration. Variations on the algorithm can use different criteria to select which box to split and how to split it. In general, you choose the biggest box to split, and split it to yield two equal parts. Size might be measured by the number of color points the box contains, or by the total number of pixels, since many pixels may have mapped to the same color point. Similarly, equality might refer to equal numbers of color points, pixels, or even simply equal volumes of the color space.

After 256 iterations of this process, you'll have 256 bins into which the color content of the original scanned picture has been distributed as evenly as possible by whichever criterion you used. The optimal palette now consists of the color held in each of these final boxes. In general, each box will contain more than one color point, so you need a third selection function to pick just one; it might be the point closest to the center of the box, or an average weighted for the number of actual mapped pixels.

This algorithm gives a "fair" representation of the color distribution in a given picture, but in practice, absolute fairness may not be desirable. A human expert might prefer to sacrifice some colors and emphasize others to better suit the content and meaning of the painting, matters of which the algorithm can know nothing.

Reference: Hekbert, P. "Color Image Quantization for Frame Buffer Displays," *Computer Graphics*, Vol.16, no. 3, 1982.

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in the National Gallery visitor's book, and the fact that utilization of the workstations runs at close to 100 percent every day.

The graphics style of the screens is very book-like, with black-on-white text set in a serif typeface arranged in columns around the pictures. The strict avoidance of colored backgrounds or lettering in the text enhances the impact of the paintings and makes them the focus of interest on the page. All computerish "screen furniture" is confined to a narrow navigation bar at the foot of the screen, and no icons, scroll bars, or menu bars are in sight. "Hot text" that invokes a hypertext link to another page or a pop-up information window is lightly shaded, and you quickly learn that clicking any shaded area will take you somewhere else. Click on any picture marked with the little four-arrows sign to zoom it and then click anywhere to unzoom it again.

Fingertip Control

Hypertext-links aside, navigation is performed using four buttons at the bottom of the screen. The two most important buttons are Next Page, which allows you to turn the page like a book, and Go Back, which allows you to return to the last page you saw (even if you left it via a hypertext jump) and retain an effectively unlimited memory trail of pages.

The Contents button takes you straight to the contents page, which is the nerve center of the browsing system. You are offered five different viewpoints into the National Gallery collection: The Painter's Lives view lets you look up painters by name; the Historical Atlas lets you look at a particular country and a particular century; Picture Types enables you to browse landscapes, still lives, portraits, nudes, and whatever; General Reference is an overall index so that you can find an explanation of, say, *gesso* or *chiaroscura*; and finally Guided Tours offers you one of four automated sessions with themes like Composition and Perspective and Making paintings.

On the Art Gallery CD-ROM, a guide's high-quality digitized voice accompanies you on these tours; however, for the Micro Gallery application, sound was deemed too distracting to other users. In addition, Art Gallery uses voice to excellent effect in the Painter's Lives section to give the correct pronunciation of names. This feature is very welcome indeed when you are faced with a Pollaiuolo, Koekkoek, or Reymerswaele.

The See Also button presents you with a context-sensitive contents page that offers you cues for further browsing—painters of the same period or similar style or paintings whose subject matter is related to the one you are currently viewing. This is the most innovative feature of Art Gallery, and a few hours spent following the See Also cues can be a genuinely educational experience. A dreaded pop-up menu is also available for the experienced computer user. The menu is well hidden behind the Options button, which allows you to print or copy the screen to the clipboard and perform text searches on the entire CD-ROM.

It's no accident that the user interface to Art Gallery is much simpler and more intuitive than the Macintosh/Windows GUIs that support it, for Cognitive Applications tried out many prototypes of the system on museum staff and members of the public and then stripped away or refined features to arrive at the current model. Perhaps art history is not the only thing you can learn in this Art Gallery. ■

Dick Pountain is a BYTE contributing editor based in London. You can reach him on the Internet or BIX at dickp@bix.com.

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Multimedia Powerhouse

KARL M. GUTTAG



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TI's new MVP chip brings parallel-processing power to multimedia applications

More and more, computers and applications are incorporating real-world data types, such as video and voice. To some people, dealing with these data types is a headache; we at Texas Instruments see it as a business opportunity. We designed a groundbreaking DSP (digital signal processor)—the MVP—to bring parallel-processing power to bear upon the problems of multimedia.

The MVP integrates onto a single die five very powerful, fully programmable processors, a sophisticated DMA controller with an external memory interface, 50 KB of SRAM (static RAM), and video timing control (see the figure "The MVP" on page 58). Of the 50 KB of SRAM, 32 KB can be shared among all five processors to support many different parallel-processing approaches. The MVP chip is targeted at solving the problems that are inherent in multimedia and other applications that require a large amount of processing.

Driven by Design

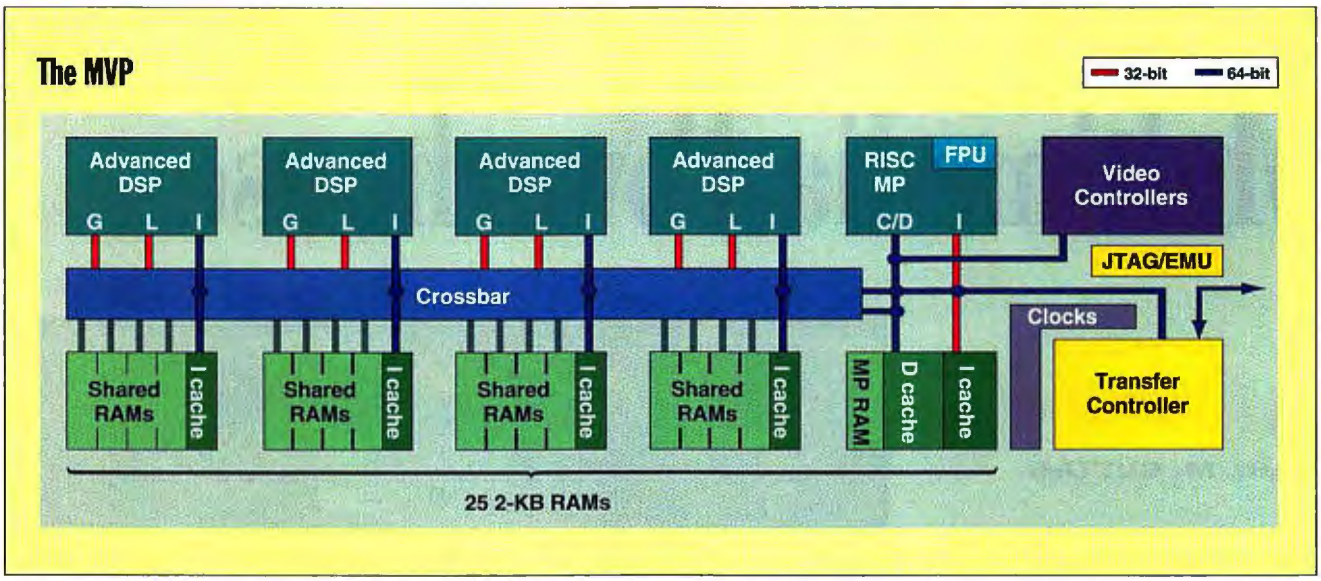
The MVP did not spring fully formed from the memories of TI's CAD workstations. Three basic algorithmic areas drove the MVP's design definition: image processing and recognition, video and still-image compression, and high-performance computer graphics.

The design of the MVP's signal-processing components was driven by the needs of image-processing, image-recognition, and image-compression algorithms. The latter category includes convolution and frequency-domain transforms that are multiplication-intensive. For example, the JPEG and MPEG standards require DCT (discrete cosine transform) frequency transforms, so TI paid particular attention to DCT performance and precision.

While the algorithms drove the design of the signal-processing components, the sheer volume of signal processing that is required by these algorithms prompted the decision to include multiple DSPs on the IC. The design team also discerned that, in general, the primary multimedia algorithms required 16-bit or less fixed-point multiplies with 32-bit accumulates. Higher precision was not required in the signal-processing components.

Historically, DSPs have not been very good at processing the bit-field manipulations used in some compression algorithms or at manipulating multiple-pixel quantities, such as those encountered in graphics block moves. The MVP's signal processors differ from traditional DSPs most markedly in their ability to manipulate bit fields and process multiple pixels in parallel through their data paths. To reflect these differences, we call these components *advanced DSPs*, or ADSPs. The MVP contains four of them.

One important point about ADSPs is that, although they are optimized for certain *types* of algorithms, they don't dedicate hardware to any specific algorithm. The goal of the MVP is to support elemental operations that can be used to implement any



Each ADSP has two independent 32-bit data ports (G and L in the figure) and a 64-bit instruction cache input (I). The MP has a single 64-bit data port (C/D) and a 32-bit instruction port. The TC (Transfer Controller) has a 64-bit internal port and a 64-bit external port. The ports of the various processors and TC are connected to 25 2-KB RAMs via a crossbar-switch network. The crossbar supports approximately 2.4 GBps of data, plus 1.8 GBps of instructions.

algorithm. This approach pays dividends when vendors develop new algorithms for current problems and when they use the power and programmability of the MVP to develop completely new applications.

Inside the Advanced DSPs

The MVP's four ADSPs provide most of the chip's raw performance. Each can perform in excess of 10 RISC-like operations per cycle (see the figure "The Advanced DSPs").

To specify the multiple parallel operations that they are able to perform, the ADSPs employ a wide instruction word of 64 bits. This instruction word has fields that independently control the data unit, along with its multiplier and data path, and the two address units. All instructions nominally execute in a single cycle.

Each ADSP has a register file of 44 programmer-visible registers. Any register can be a source to, or a destination from, the ALU data path. This includes the program counter, the address registers, and the loop-control registers. Conditional PC (program counter) relative jumps, for example, are performed by conditionally writing to the PC. The register set is broken into files based on register functions. Most of the registers support more than one access per cycle, with the register file in the data unit supporting over 10 accesses in a single cycle.

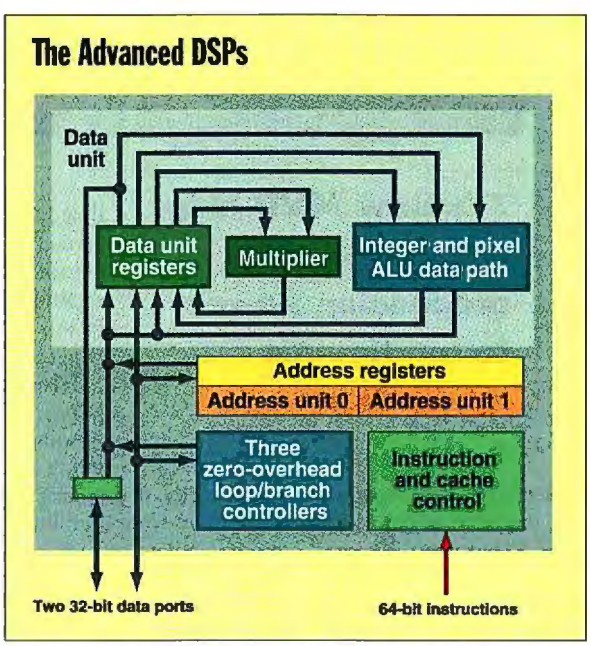
An ADSP data unit consists of three major elements: the data-unit user registers, the multiplier, and the ALU data path. The instruction set supports independent multiplier and ALU data path operations. The multiplier can perform one 16- by 16-bit multiply or two 8- by 8-bit multiplies in a single cycle. The multiplier also has a rounding option, a direct result of maintaining the specified accuracy for the video-compression standards. Whereas the ALU data path can operate on any of the registers, the multiplier is restricted to operating on eight data-file registers.

The ALU data path includes a barrel rotator, a mask generator, a 1-to-*n* bit expander (which is used for binary-to-color transforms, among other things), and a three-input ALU that can combine the mask or expander output with register data to create over 2000 different processing options. The ALU has a 32-bit data path that performs logical and arithmetic functions, and it can combine these to support masking or merging in a single pass. The ALU can be split into smaller sections to perform multiple 8- or 16-bit operations in parallel.

Normally, ALU operations set four status bits: carry, negative, zero, and overflow. Any or all of these bits can be protected from being modified by the current instruction. The instruction set supports both conditional source selection between a pair of registers and writing of the result based on status.

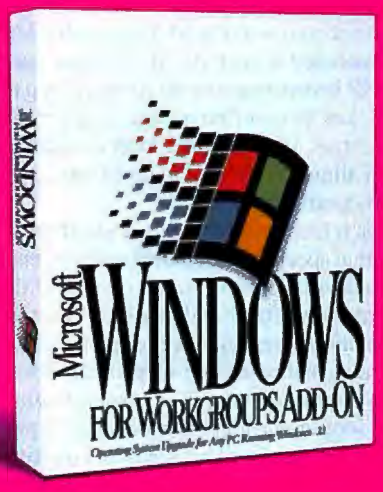
The two address units are nearly identical, and together they can perform two memory operations per cycle. Each memory operation is a load or a store that can be totally independent of the data-unit operation. The address units add an immediate or register index to an address register to form the address. The result of the address computation can optionally modify the address register to facilitate stepping through a memory array.

Like the ALU data path, the two address units support conditional



Like other DSPs, those integrated with the MVP are built to support multiple data accesses in a single cycle and to optimize the performance of the multiply-accumulate operations that characterize signal-processing algorithms. In addition, the ADSPs also support bit-field and pixel operations, making them powerful imaging and graphics processors as well.

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operations. The source for a store can choose between a pair of registers, and the decision whether or not to load a register can be based on status. The source or destination of a store or a load can be any of the 44 registers. A conditional load of the PC performs a conditional jump, which can free up the ALU data path to perform other operations.

Either or both address units can be used to perform a data operation in place of a memory transfer. In such a case, the result of the address data path is written to the destination register instead of data being fetched from memory. This capability, along with conditional loads of the PC, speeds up functions that are computationally bound or jump-bound rather than memory-access-limited.

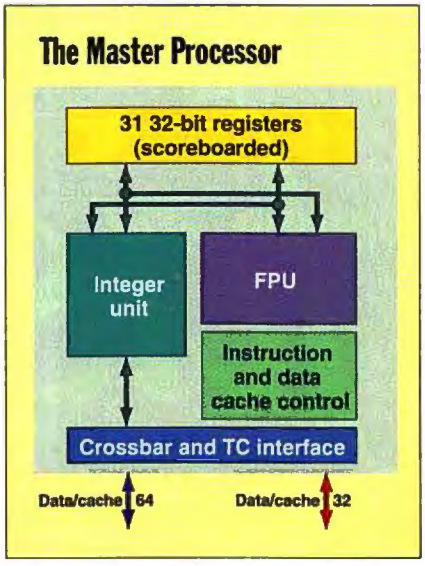
Three zero-overhead loop controllers are included in each ADSP. Because each ADSP instruction can do so much in parallel, key loops often require very few instructions. Having three loop controllers even allows for nested loops to have zero loop-control overhead.

Each loop controller has a set of registers that specifies the starting address, ending address, current loop count, and the initial count (for nested looping). Once the loop-control registers are initialized, loop counting and branching are performed with zero overhead in terms of execution time. The loop controllers can be used to perform zero-overhead branches to a run-time patch in code segments. Because the loop-control registers sit in the register file, you can write computational results to a loop-count register to specify whether or not a branch is taken based on a zero result.

Instruction prefetch and the instruction cache are controlled from within each ADSP. Instructions are executed in a three-cycle pipeline, with a new instruction starting every cycle, assuming that no stalling condition has occurred. The ADSPs' instruction controllers support interrupts and emulation control. If a cache miss occurs, the cache controller will make a packet request to the TC (Transfer Controller; described later) to get the new cache subblock transferred.

Beyond DSP

In addition to signal processing and bit-level manipulations, multimedia processing requires many other types of operations, such as 3-D graphics and audio processing. These applications often require high-precision floating-point computations. Because a single FPU was all that could fit on the MVP's die, floating-point capability was not incorporated into the ADSPs but built into a separate processor called the Master Processor, or MP (see the figure "The Master Processor"). The FPU contains a special set of instructions to support 3-D graphics transforms and DSP-like floating-point operations.



The MP consists of both an integer unit and an FPU. Control of the instruction and data caches is integrated into the processor, although the cache memory resides in the SRAM array.

The MP is a general-purpose RISC processor that is programmable generally in high-level languages. It performs operations requiring a higher level of precision than is available from the ADSPs.

The MP integer unit has a 32-bit instruction word that performs integer register-to-register or load/store instructions nominally in one cycle. The basic load or store operation adds an index to a register containing the base address to form the memory address. To step an address pointer through memory, the instruction can optionally update the register that's used as the base-address register with the result of the add.

The IEEE-754 FPU is pipelined and runs in parallel with the integer unit. In normal operation, a new floating-point add or multiply can be initiated every cycle. A special set of parallel floating-point operations can initiate a multiply, an addition or subtraction, and a 64-bit load or store with automatic increment addressing every cycle.

The register file contains 31 32-bit registers that are common to both the integer unit and the FPU. The registers are scoreboarded for floating-point results and memory-load operations. The scoreboard allows the MP to continue execution; the MP will stall only if an instruction tries to use a register before the prior operation has loaded its result. As with some other RISC architectures, R0 is a dummy register that is always read as zero.

Instruction flow and cache management are controlled within the MP. A three-stage pipeline starts a new instruction every cycle, assuming no stalling conditions have occurred. The instruction controller also deals with interrupts and emulation support. The MP has hardware for managing the 4-KB data and 4-KB instruction caches. When a cache miss occurs, the MP's cache controller automatically makes a packet request to the TC to get the necessary data transferred.

Communications Matters

The final important consideration in designing the MVP was the need for high data bandwidth for off-chip communications and interprocessor communication. This requirement is common to signal processing, floating-point processing, and graphics processing. Much of the early architecture definition focused on achieving high bandwidth, making sure that the processors wouldn't have to wait on data, and ensuring that interprocessor communication would not be a bottleneck.

CPU	DSP
• Generalized functions	• Signal processing
• Single data bus	• Multiple data buses
• Hardware cache control	• Programmer-accessible caches
• Generalized addressing	• Loop-optimized addressing
• Hardware manages microarchitecture	• Programmer manages microarchitecture

To address internal communications issues, we incorporated 25 small, 64-bit-wide RAMs on the MVP chip. These are accessed by the processors through a crossbar interconnection. To handle external communications, we incorporated on-chip an intelligent DMA controller for handling block data movement: the TC (Transfer Controller), mentioned earlier.

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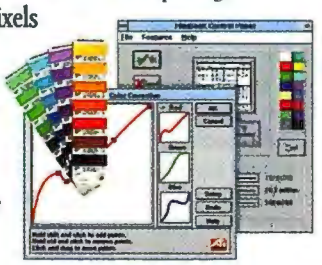
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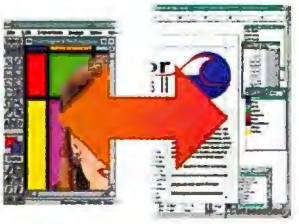
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Winbench 3.11* 1024 X 768/256 colors pixels/sec	**123.0**	93.5	85.1
Winbench 4.0* 1024 X 768/256 colors pixels/sec	**42.5**	35.5	23.9
Winbench 4.0* 800 X 600/16.7 M colors pixels/sec	**26.0**	14.9	5.6
DOS Performance †† xpels/sec	**3,871**	575	1,685
Motion Video Performance ††† frames/sec	**24**	11	13

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* All performance tests done on a Pentium P54C 100MHz, 16MB RAM, 256K cache, 420MB HD, using 2MB PCI graphics cards. † Winbench 3.11 at 1024x768 resolution, 256 colors at 70Hz. †† DOS performance tested using PC Bench 8.0 (video harmonic) ††† Motion Video performance measured under Windows using 65K colors. Test clip recorded at 320x240 at 30 fps using Indeo codec.

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ADSP uses one 2-KB block as a hardware-managed instruction cache that is loaded by the TC in the event of a cache miss. The MP uses two 2-KB blocks as an instruction cache and two more as a data cache. Finally, one 2-KB block is reserved as fast RAM and is accessible only by the MP and TC.

The remaining 32 KB of RAM is shared and can be accessed in chunks of 8, 16, 32, or 64 bits at a time; the large number of individual RAMs supports many parallel accesses. A crossbar-switch network lets the following accesses to shared RAM occur simultaneously: two 32-bit accesses by each ADSP, a 64-bit access by the MP, and a 64-bit access by the TC.

Crossbar-switch connections are determined by the most significant bits of each address on a cycle-by-cycle basis. If more than one access is requested of the same RAM block in a cycle, round-robin-prioritization hardware determines which processor is allowed access and which processor is stalled until the next cycle.

All the shared RAMs and the one MP/TC 2-KB RAM block reside at fixed addresses and are managed by software. Generally, the processors send packet-request commands to the TC to load data before it is needed for processing and to store results after processing. Because of the number of individual RAMs available, these packet transfers can be set up so that they do not conflict with other accesses and therefore work fully in parallel with other processing.

Crossbar-shared memory is the most generally flexible multiprocessor memory architecture because it puts the fewest restrictions on how data must be organized. While the crossbar involves nearly 1000 data and address lines that must be connected between the processors and memory, it becomes practical to use because everything is integrated on one chip. The crossbar's flexibility translates into better efficiency, in terms of both execution speed and ease of programming.

TARGET APPLICATIONS

- Videoconferencing
- Document image processing
- X Window System terminals
- Imaging
- 3-D graphics
- Compression
- Cellular base stations
- Virtual reality
- Video servers
- Neural networks

The Transfer Controller

The transfer controller is a very intelligent DMA controller that can autonomously transfer packets of data between the MVP and external memory (see the figure "The Transfer Controller"). The TC can address memory as either a linear or a multidimensional array of data or even as a complex shape, such as a polygon. The TC is byte-addressable and will automatically handle byte misalignment between the source and the destination. Requests for packet transfers can be made by any of the processors under program control, as well as by the cache controllers and the video controller for display refresh. Transfers can also be initiated by external requests.

The TC processes the source and destination addressing with independent controllers. The burst FIFO (first-in/first-out) supports DRAM page and burst modes and buffers byte-misaligned accesses to more efficiently move data. A separate cache-access controller can break into the middle of program-controlled packet transfers to service cache misses. The request-prioritization/control logic prioritizes the many potentially active requests and starts transfers. The TC will automatically suspend and later resume lower-priority requests when a higher-priority request occurs.

The external memory interface provides support for ROMs, SRAMs, DRAMs, and VRAMs (video RAMs). The support for DRAMs, including timing control and address multiplexing, is relatively new in DSPs. The combination of fast on-chip SRAM and an external DRAM interface supports high performance while also reducing system costs.

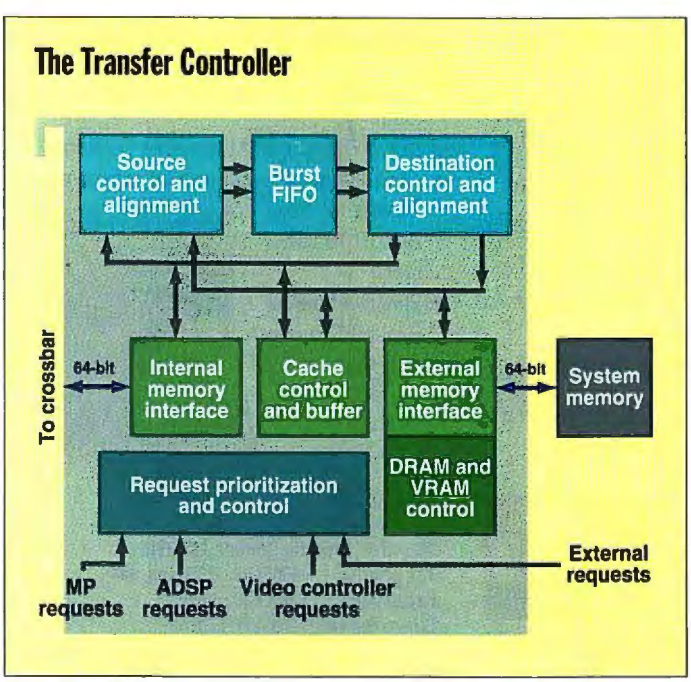
The TC is capable of transferring data between sources and destinations that have different dimensions. In graphics and imaging, for example, it is common for the TC to fetch data from an image region as a 2-D array and bring it on-chip for processing as a linear array. After processing, the results stored in a linear array can then be stored off-chip as an x,y array. The ability of the TC to make these transformations autonomously greatly improves the efficiency of processing by the ADSPs and the MP.

The MVP chip has two sets of video-timing counters and registers. The video controller keeps track of horizontal and vertical synchronization and blanking timing, as well as supporting a 2-D border region. Each counter has its own asynchronous clock input and has a set of synchronization, blanking, and border signals. The synchronization signals can be individually set up as outputs (for display) or inputs (for video capture). An SRT (shift-register transfer controller) has comparators that cause shift-register transfer cycles for VRAMs or cause packet transfers for DRAM base-display memory.

Support Issues

Although perhaps not as exciting as the microarchitecture, testability and software debugging were important concerns in the MVP design, and roughly 10 percent of the chip's nonmemory transistors are dedicated to these functions. All storage nodes can be scanned in or out to support boundary-scanned testing. Other features in the scan path support emulation loading and the dumping of the internal state of the MVP. Address comparators were also added to support real breakpoints.

A complete suite of software support has been developed for the MVP chip. Assemblers and C compilers have been



In addition to controlling the movement of data and instructions on- and off-chip, the TC performs transformations where data is processed in an order different from that in which it is stored. The TC also contains a DRAM and VRAM controller.

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F760i-W	21"	0.28mm	H:30-78kHz V:55-90Hz	1280x1024
F560i-W	17"	0.26mm	H:30-82kHz V:55-90Hz	1280x1024
F550i-W	17"	0.28mm	H:27-65kHz V:55-90Hz	1024x768
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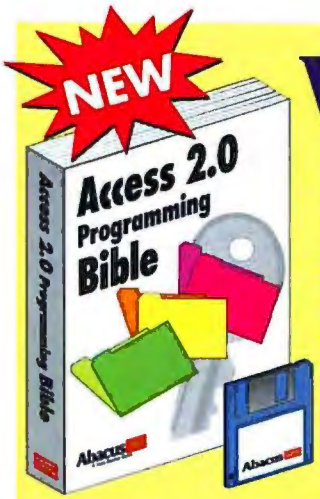
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developed for the MP and the ADSPs. A C-like algebraic assembler for the ADSPs supports the many different operations that they can perform. Software-simulation and hardware-emulation tools that use the same graphical interface are available. An imaging and graphics software library is also currently being developed. An MP-resident executive supports multitasking and intertask synchronization and communications. Under the executive, tasks running on the MP issue commands that are carried out by the ADSPs.

Putting It All Together

Through the use of parallel processing, the MVP puts a new level of programmability and performance on a single IC. Not only does the MVP integrate five processors on a single chip, but each processor can execute many operations in parallel. The MVP is implemented on a 342mm² die, using a 0.6-micron, three-metal-layer process. It uses a 3.3-V power supply and will initially run at 40 MHz, with 50-MHz parts due next year. The MVP is packaged in a ceramic pin-grid array, but it will eventually move to a composite metal-plastic package. It draws 7.5 W at 50 MHz.

The MVP is capable of performing the equivalent of over 2 billion RISC-like operations per second. In specific applications, a single MVP can do the job of over 10 of the most powerful DSPs or general-purpose processors previously available. The MVP can move 2.4 GB of data and 1.8 GB of instructions within the chip—plus shuffle 400 MB of data to off-chip memory—per second.

Some of the obvious uses for the MVP chip will be multimedia applications, such as videoconferencing; document-image processing, from digital copiers to real-time OCR; 2-D and 3-D graphics; audio enhancement and compression; telecommunications; and virtual reality. But the real virtue of the MVP is that its combination of programmability and performance will undoubtedly lead to applications that are as yet unimagined. ■

ACKNOWLEDGMENTS

I wish to thank all the people who made the MVP a reality, especially co-architects Bob Gove, Nick Ing-Simmons, Keith Balmer, and program manager Walt Bonneau. The development of the MVP was a worldwide TI project, involving TI employees in Houston; Dallas; Bedford, England; and Bangalore, India.

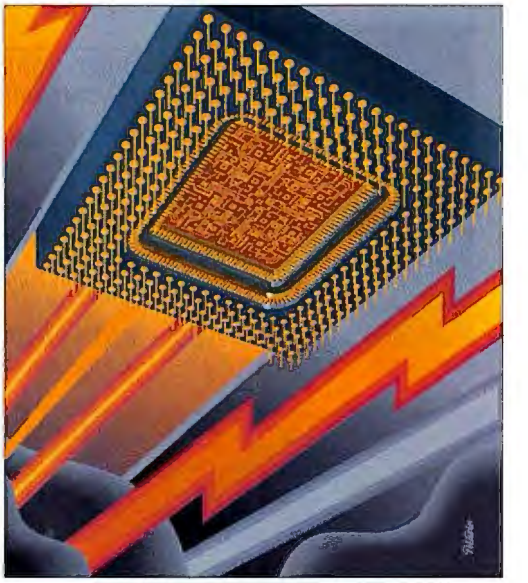
Karl M. Guttag is a TI Fellow and chief architect of the MVP chip. You can contact him on the Internet at karl@video.sc.ti.com or on BIX c/o "editors."

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1994 BYTE READERS' CHOICE AWARD

1994 Readers' Choice Awards

BYTE readers are an eclectic and savvy bunch, and this is reflected in the results of the 1994 Readers' Choice Awards. In most cases, familiar favorites dominate the product categories: You still like Gateway PCs, IBM workstations, and Microsoft word processors. Aldus and Adobe remain top guns in graphics software, which bodes well for Adobe's recent acquisition of Aldus. And the seesaw battle for the top spot in the notebook category actually produced a tie this year, with perennial contenders Apple (with its Mac PowerBooks) and IBM (with its ThinkPads) sharing the honors.



The most incongruous result showed up in the voting for Software Product of the Year. IBM's OS/2 took top honors, despite the fact that Windows was voted the best operating system/environment. What looks like a contradiction at first glance could simply be your way of recognizing the superior technology of OS/2 2.x while still acknowledging the practical importance of Windows.

Hardware Product of the Year voting also featured a battle of rivals: Intel and its Pentium versus IBM/Motorola and the PowerPC. The Pentium won by a comfortable margin, but the voting results serve notice of your growing awareness of, and interest in, the RISC-based PowerPC architecture. It will be interesting to see how you rate these rivals in future years.

The BYTE Readers' Choice Awards are the result of a random sampling of BYTE subscribers conducted in conjunction with the February '94 issue. Because they come from you, these awards better reflect a product's performance and acceptance in the real world than can any review or editors' award.

HARDWARE
PRODUCT OF THE YEAR
Pentium,
Intel

RUNNERS-UP:

PowerPC 601,
IBM/Motorola

ThinkPad 750c,
IBM

DESKTOP COMPUTER—PC
GATEWAY 4DX2-66V,
Gateway 2000

RUNNERS-UP:

GATEWAY P5-60,
GATEWAY 4DX2-66,
Gateway 2000

DESKTOP COMPUTER—MACINTOSH
APPLE MACINTOSH QUADRA 950,
Apple Computer

RUNNERS-UP:

QUADRA 650,
QUADRA 610,
Apple Computer

WORKSTATION
IBM RS/6000 SERIES,
IBM

RUNNERS-UP:

HP 9000 SERIES,
Hewlett-Packard

SUN SPARCSTATION 10,
Sun Microsystems

LAPTOP/NOTEBOOK COMPUTER
TIE: IBM THINKPAD SERIES,
IBM

MACINTOSH POWERBOOK SERIES,
Apple Computer

RUNNER-UP:

TRAVELMATE,
Texas Instruments

HAND-HELD COMPUTER
MESSAGEPAD,
Apple Computer

RUNNERS-UP:

GATEWAY HANDBOOK,
Gateway 2000

HP LX SERIES,
Hewlett-Packard

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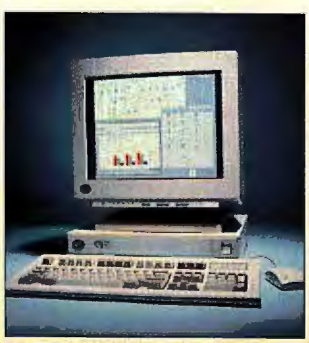
RUNNERS-UP:
VIEWSONIC 17,
ViewSonic

APPLE RGB,
Apple Computer

LASER PRINTER

LASERJET 4M,
Hewlett-Packard

RUNNERS-UP:
LASERJET IIIP,
LASERJET IIISI,
Hewlett-Packard



IBM RS/6000 PowerStation 25T

MODEM

PRACTICAL MODEM PM9600SA,
Practical Peripherals

RUNNERS-UP:
SPORTSTER,
U.S. Robotics

PROMODEM ULTIMA,
Prometheus

VIDEO BOARD—PC

DIAMOND VIPER,
Diamond Computer Systems

RUNNERS-UP:
ATI ULTRA PRO,
ATI Technologies

PARADISE WD24,
Western Digital

VIDEO BOARD—MACINTOSH

THUNDER 24,
SuperMac Technology

RUNNERS-UP:
PRECISION COLOR 24X,
Radius

PAINTBOARD XL,
RasterOps



Apple MessagePad



HP LaserJet 4M

SOFTWARE
PRODUCT OF THE YEAR

IBM OS/2 2.x,
Microsoft

RUNNERS-UP:
Word for Windows,
Microsoft

WordPerfect for Windows,
WordPerfect

WORD PROCESSOR—PC PLATFORM

WORD FOR WINDOWS,
Microsoft

RUNNERS-UP:
AMI PRO,
Lotus Development

WORDPERFECT FOR WINDOWS,
WordPerfect

WORD PROCESSOR—MACINTOSH

WORD FOR MACINTOSH,
Microsoft

RUNNERS-UP:
WORDPERFECT,
WordPerfect

MACWRITE PRO,
Claris

CAD PROGRAM—PC PLATFORM

AUTOCAD,
Autodesk

RUNNERS-UP:
GENERIC CADD,
Autodesk

MICROSTATION,
Intergraph

CAD PROGRAM—MACINTOSH

CLARIS CAD,
Claris

RUNNERS-UP:
DESIGNCAD MACINTOSH,
American Small Business Computers

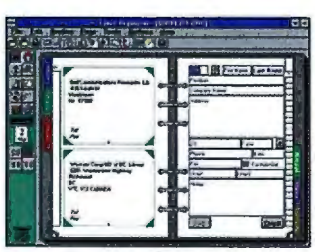
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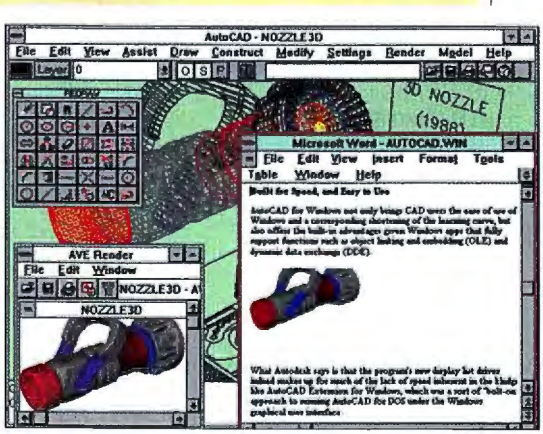
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RUNNERS-UP:
ACT,
Symantec

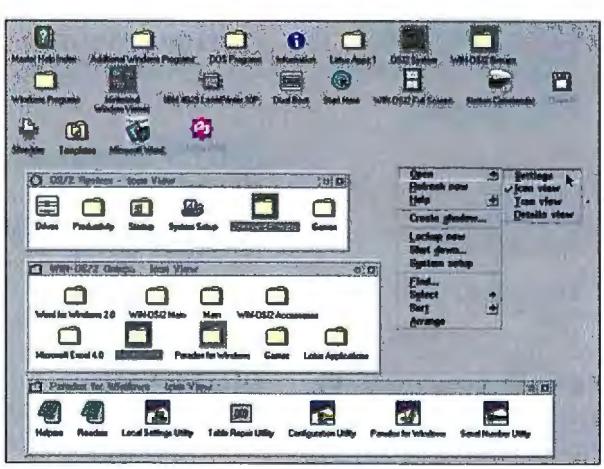
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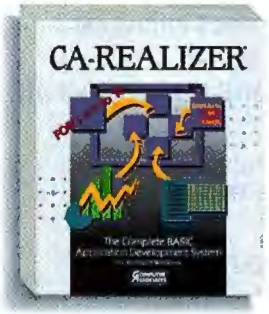
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OS/2 2.1

A Better Basic.

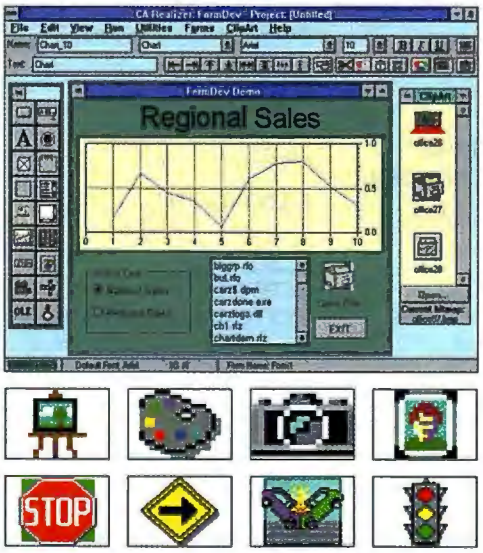
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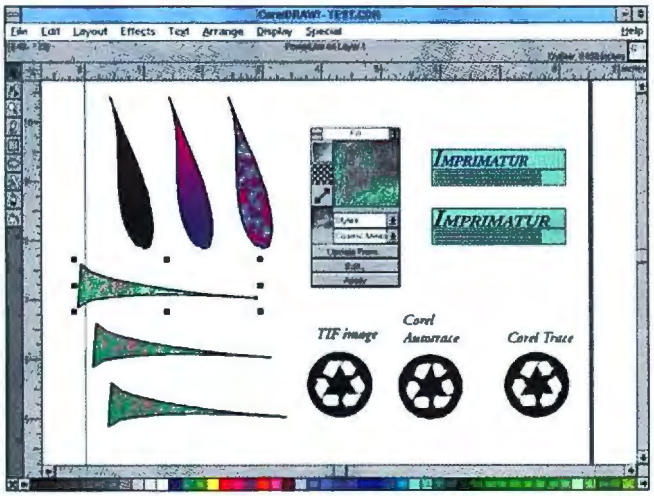
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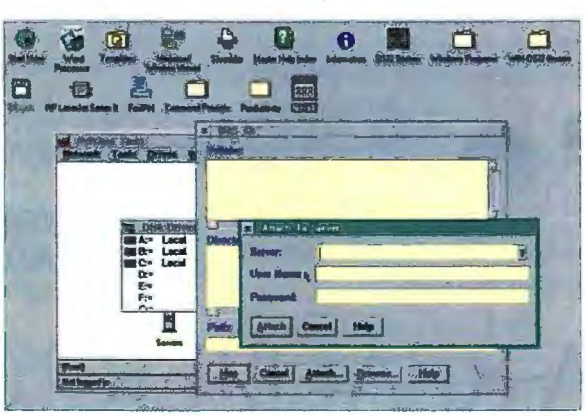
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The new TI TravelMate 4000E WinDX4/75MHz notebook. With its IntelDX4 processor, you have the power to be more productive.

At Texas Instruments, we've listened to your needs. That's why we've created a way for you to work faster and increase your productivity — with the new TravelMate WinDX4/75 active matrix color notebook computers.

You'll find a lightning-fast 75MHz IntelDX4 processor inside. Combined with our innovative system architecture, your new TravelMate will scream with speed. And with 3 to 5 hours of battery life and a 455MB hard drive, you can be more productive even when you're on the go.

Finally, with so many high-performance features packed in, who needs a desktop PC? The TravelMate 4000E WinDX4/75 does it all. To learn where you can reserve yours today, simply call **1-800-TI-TEXAS** (1-800-848-3927), after all, they're going fast.

TRAVELMATE 4000E SERIES NOTEBOOKS

DISPLAY	PROCESSOR	MEMORY†
Active Matrix Color (9.5")	IntelDX4-75MHz	4MB RAM/455MB HDD
Active Matrix Color	IntelDX4-75MHz	4MB RAM/340MB HDD
Active Matrix Color	486DX2-50MHz	4MB RAM/200MB HDD
Dual Scan Color	486DX2-50MHz	4MB RAM/200MB HDD
Color	486DX2-40MHz	4MB RAM/200MB HDD
Color	486SX-25MHz	4MB RAM/120MB HDD
Monochrome	486DX2-50MHz	4MB RAM/200MB HDD
Monochrome	486SX-25MHz	4MB RAM/120MB HDD

TRAVELMATE INTELLIGENT DOCKING SYSTEM

COMPATIBILITY	EXPANSION	INTERFACES
TI TM4000E Series Notebooks	Six 16-bit ISA slots, two PCMCIA Type III slots, four drive bays	Parallel/2 Serial, VGA, Mouse, keyboard, game port and RJ-11 jack

† RAM expandable to 20MB with optional memory

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LOTUS FREELANCE GRAPHICS,
Lotus Development

RUNNERS-UP:
POWERPOINT,
Microsoft

SPC HARVARD GRAPHICS,
Software Publishing

PRESENTATION GRAPHICS—MACINTOSH

PERSUASION,
Aldus

RUNNERS-UP:
POWERPOINT,
Microsoft

CA-CRICKET PRESENTS,
Computer Associates International

OPERATING SYSTEM/ ENVIRONMENT—ALL PLATFORMS

MICROSOFT WINDOWS,
Microsoft

RUNNERS-UP:
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IBM
MS-DOS,
Microsoft

PROGRAMMING LANGUAGE—PC PLATFORM

BORLAND C++,
Borland International

RUNNERS-UP:
VISUAL BASIC,
Microsoft

VISUAL C++,
Microsoft

PROGRAMMING LANGUAGE—MACINTOSH

SYMANTEC C++,
Symantec

RUNNERS-UP:
HYPERCARD,
Apple Computer

THINK C,
Symantec

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Microsoft

RUNNERS-UP:
HARVARD PROJECT MANAGER,
Software Publishing

CA-SUPERPROJECT,
Computer Associates International

SPREADSHEET—PC PLATFORM

MICROSOFT EXCEL,
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QUATTRO PRO FOR WINDOWS,
Borland International

1-2-3 FOR WINDOWS,
Lotus Development

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MICROSOFT EXCEL,
Microsoft

RUNNERS-UP:
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WINGZ,
Informix Software

UTILITY PACKAGE—PC PLATFORM

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Symantec

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Central Point Software

NORTON DESKTOP FOR WINDOWS,
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Symantec

RUNNERS-UP:
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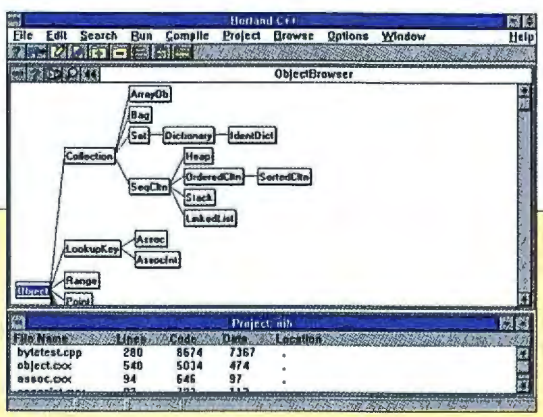
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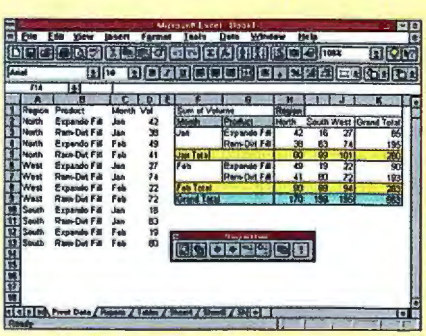
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WordPerfect
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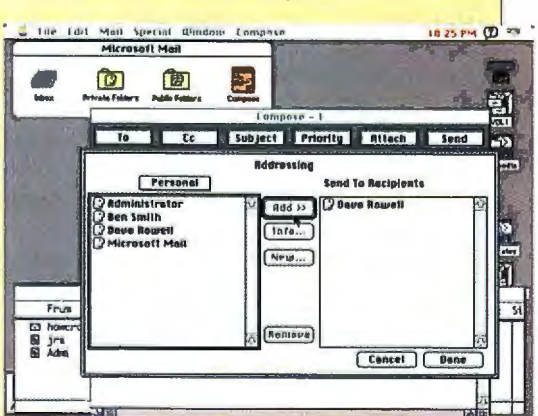
Borland C++ 3.1



Lotus Freelance Graphics



Microsoft Excel 5.0 for Windows



Microsoft Mail

When protecting your software against piracy and unauthorized use, make sure that your protection system has all the following qualities:

A GOOD HARDWARE KEY



Hardware-based software protection systems are now the standard worldwide. However, not all keys are the same. A good key should have all the following features:

✔ Compatibility and transparency. The key should work without any problem on your customers' computers. The user should be able to forget the key after connecting it.

✔ Unbreakable electronics. A customized ASIC (Application Specific Integrated Circuit) component integrated into the key to prevent reverse engineering and make cracking the hardware virtually impossible.

✔ A unique and inaccessible developer's code burnt into the ASIC. This code should never be held in the key's memory, where it can be read and altered.

✔ A Read/Write Memory inside the key should be available. The memory should be writable in the field, on any PC, without any special programming equipment.



✔ Very low power consumption, enabling the key to work even under the most adverse power conditions, on PCs and laptops, with or without a printer.

POWERFUL SOFTWARE

✔ A Linkable Protection Module with which calls can be made to the key from any point in the protected program.

✔ An "Envelope" encryption program. Such programs enhance security while making it possible to protect a software application even without its source code.

✔ Sophisticated antidebugging and encryption mechanisms.

HASP® - The Professional Software Protection System



MacHASP - The Professional Software Protection System for the Macintosh

HASP® OFFERS YOU ALL THESE FEATURES AND MORE:

HASP was designed by a team of computer experts, professional cryptologists, and electrical engineers. As a result, HASP keys are supported by what is probably the best software in the market, and the HASP system has worked on every computer it has been tried on. In addition to all the features mentioned above, HASP provides:

✔ A Full Authorization System for protecting dozens of programs using only one key.

✔ A Pattern Code Security System (PCS) which enables parallel processing of multiple calls by the Linkable Protection Module.

✔ A Virus Detection option that can be incorporated in the protected program to check whether it has been infected by a virus.

✔ Several HASP keys can be connected one behind the other. Small physical size ensures maximum convenience for your customers.

NETHASP- THE ULTIMATE SOFTWARE PROTECTION FOR NETWORKS

✔ Only one NetHASP key is needed to run a protected program from any station in a network. NetHASP provides full support for protecting DOS and WINDOWS software under network environments, including Novell dedicated & non-dedicated servers, Lan Manager, Lantastic, Banyan, DLink, and NET-BIOS based LANs.

LISTEN TO THE EXPERTS:

In all the products we tested, except the **HASP**, we could see through the encrypting and questioning procedures... and crack them.

CT Magazine (Germany)

MemoHASP: ...of all the protection devices tested is without any doubt, the one which combines the best features.

PCompatible (Spain)

Trying to crack a program... that was protected utilizing all of **HASP**'s features - is like searching for the Holy Grail.

Micro Systems (France)

PC dongles... come with varying claims as to their transparency. The majority suffer from problems when a printer is connected... the DESkey and **HASP-3** are not affected...

Program Now (Britain)

Of all keys tested, **HASP** is the most ambitious one... the quality of **HASP** manufacturing seems excellent.

PC Compatible (France)

An easy to use software protection system for the Macintosh, which ensures an effective defense against software piracy...
Life is difficult for pirates... **MacHASP** is an optimal protection method, for the programmers... and for the users...

Bit Magazine (Italy)

OPERATING ENVIRONMENTS

PC: DOS, Windows, Windows-NT, Win 32s, OS/2, SCO Unix, SCO Xenix, Interactive Unix, AIX, Autocad, DOS Extenders, LANs
MAC: MAC, PowerMAC (ADB port)
NEC: DOS, Windows
AMIGA

AND THE BOTTOM LINE:

We offer some of the most competitive prices in the market. Since 1984, HASP has enabled thousands of software producers in more than 60 countries, including several Fortune 500 companies, to protect their software.

Call now for your HASP evaluation kit.

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Fax: 212-564 3377

International Office — **Aladdin Knowledge Systems Ltd.**
15 Beit Oved St., Tel Aviv, Israel
P.O.Box 11141, Tel Aviv 61110
Tel: 972-3-5375795
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yes It runs with NetWare

OS/2

UL

■ **Australia** Conlab 3 8985685 ■ **Belgium** Akkermans 3 2338826 ■ **Czech** ATLAS 2 766085 ■ **Chile** Micrologica 2 222 1388 ■ **Denmark** SC Metric 42 804200 ■ **Finland** ID-Systems 0 870 3520 ■ **Germany** CSS 201 7498640 ■ **Greece** Unibrain 1 6856320 ■ **Holland** Akkermans 45 241444 ■ **Italy** Partner Data 2 26147380 ■ **Japan** Athena, 3 58 213284 ■ **Korea** Dae-A 2 848 4481 ■ **New Zealand** Training , 4 5666014 ■ **Poland** Systherm 61 475065 ■ **Portugal** Futurmatica 1 4116269 ■ **South Africa** D Le Roux, 11 886 4704 ■ **Spain** PC Hardware, 3 4493193 ■ **Switzerland** Opag 61 7112245 ■ **Taiwan** Teco 2-555 9676 ■ **Turkey** Mikrobeta 4-4677504

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Adobe Systems, Inc.
P.O. Box 7900
1585 Charleston Rd.
Mountain View, CA 94039
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(415) 961-4400
fax: (415) 961-3769
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411 First Ave. S
Seattle, WA 98104
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(206) 622-5500
fax: (206) 343-3360
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(408) 431-1000
fax: (408) 431-4122
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Beaverton, OR 97006
(800) 964-6896
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fax: (503) 690-8083
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1801 Industrial Cir.
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fax: (515) 221-1806
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fax: (408) 433-1928
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North Sioux City, SD 57049
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(605) 232-2000
fax: (605) 232-2023
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3000 Hanover St.
Palo Alto, CA 94304
(800) 752-0900
(415) 857-1501
fax: (800) 333-1917
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(800) 426-3333
(914) 765-1900
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Menlo Park, CA 94025
(800) 331-1763
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Intergraph Corp.
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(800) 345-4856
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Interleaf, Inc.
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fax: (617) 290-4943
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4000 Civic Center Dr.
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55 Cambridge Pkwy.
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(617) 577-8500
fax: (617) 693-6060
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Microsoft Corp.
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Redmond, WA 98052
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fax: (206) 936-7329
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(602) 438-3000
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fax: (415) 506-7200
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Polaris Software, Inc.
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fax: (619) 592-7430
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(805) 497-4774
fax: (805) 374-7200
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Tualatin, OR 97062
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(503) 692-9600
fax: (503) 691-1101
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Quark, Inc.
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Denver, CO 80203
(800) 788-7835
(303) 894-8888
fax: (303) 894-3399
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Radius, Inc.
1710 Fortune Dr.
San Jose, CA 95131
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(408) 434-1010
fax: (408) 954-1927
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RasterOps Corp.
2500 Walsh Ave.
Santa Clara, CA 95051
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(408) 562-4200
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Circle 1396 on Inquiry Card.

Software Publishing Corp.
3165 Kifer Rd.
Santa Clara, CA 95056
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fax: (408) 980-0729
Circle 1397 on Inquiry Card.

Sun Microsystems, Inc.
2550 Garcia Ave.
Mountain View, CA 94043
(800) 786-0404
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fax: (408) 942-0218
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SuperMac Technology, Inc.
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(800) 334-3005
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fax: (408) 541-6150
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fax: (510) 658-9441
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Cupertino, CA 95014
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(408) 253-9600
fax: (503) 334-7400
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P.O. Box 655474
Dallas, TX 75265
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(512) 794-5970
fax: (512) 250-7329
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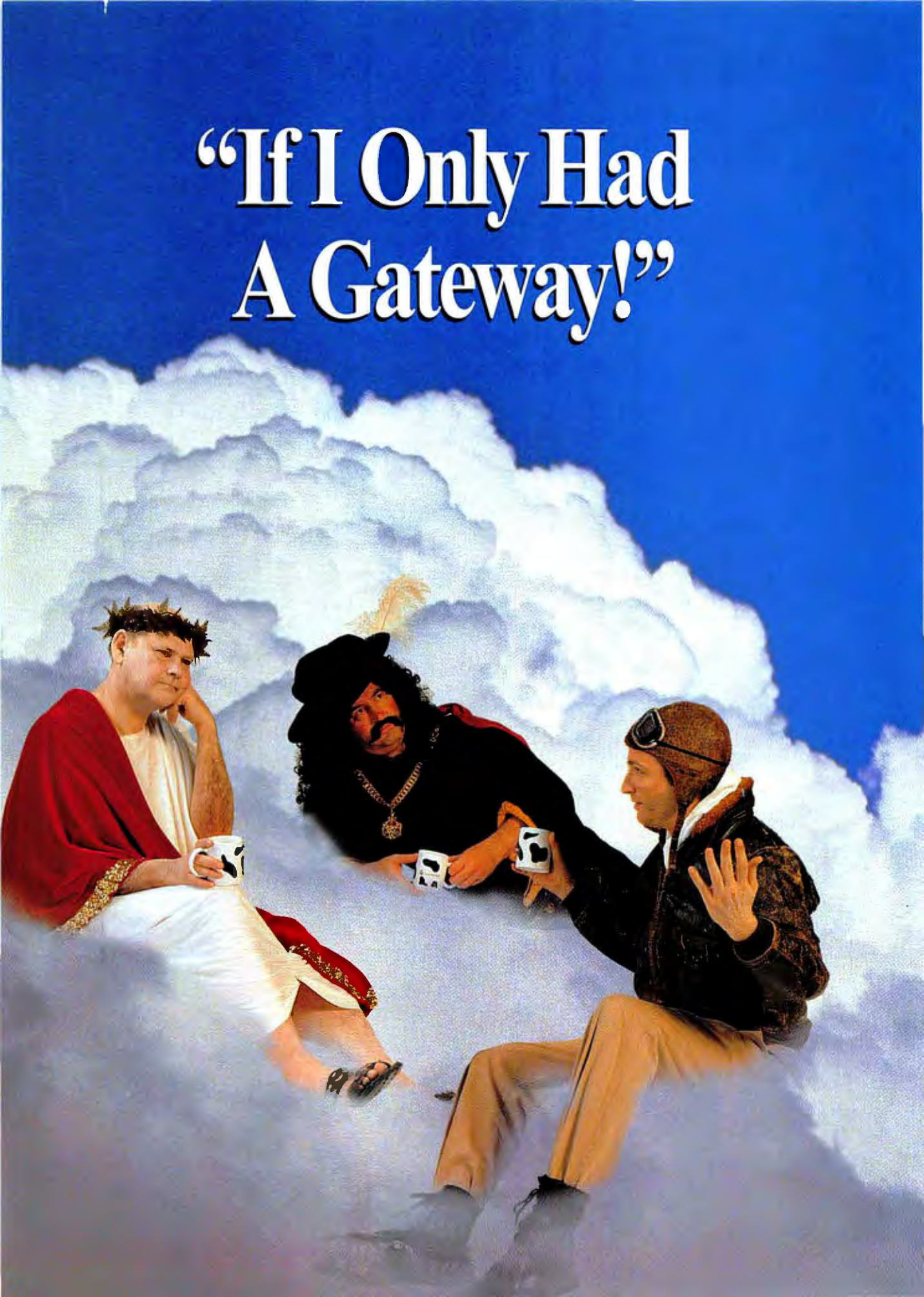
U.S. Robotics, Inc.
8100 North McCormick Blvd.
Skokie, IL 60076
(800) 342-5877
(708) 982-5010
fax: (708) 982-5235
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Orem, UT 84057
(800) 451-5151
(801) 225-5000
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"If I Only Had A Gateway!"



There I was, eating Mama's spaghetti, when Guido and the boys come over, 'Yo Bonanno! Your tower, it'sa leanin.'



Mama-mia! What'sa matta me! That'sa last time I buy a kit from the Towers-R-Us catalog. Never get enough cement mix. So, I used my mother-in-law's linguine sauce as extra cement. Oh boya, I no like how that turned out. And that'sa last time I tell the workers we eat only after the foundation is laid!



I guess they tried to tell me the soil was bad. I thought they said the 'royal' was bad. And they were right – that King Antonio waza pretty nasty.

If I had a Gateway P5-90, I coulda designed my own tower. And it woulda been magnifico! The best tower the world ever saw.

Looka me. I coulda done so much better. It'sa too late for me and my tower. Don't you be offa plumb, and be saying like me, 'Gee, I wish I woulda had a Gateway.'

Bonanno Pisano was the chief engineer of the Tower of Pisa. Soft soil and only 10 feet of foundation caused the tower, star in 1174, to begin leaning almost immediately. Over the years efforts to halt the leaning have been futile. Bonanno was not Gateway user.

"Gateway's Pentium Architecture Would've Set Me Straight"

...Bonanno Pisano, engineer, 1174

"If I only had a Gateway!" — the anguished, rueful cry of a non-Gateway user. The lesson: Don't leave the success of *your* landmark projects to an archaic system. Get a Gateway 2000® PC and you'll have the latest technology in a high-quality PC, built to stand the tests of time. You get straightforward service and support from Gateway's knowledgeable employees. And best of all ... no regrets coming back to haunt you!

Gateway's Superstructures

Look at it from this angle. You just gotta have the most powerful PC architecture available today, right? But there's no way you want to pay skyscraper prices, true? Your solution? Gateway 2000's P5 systems! These Pentium™-based machines are designed to give you all-around monumental performance — they're some of the fastest PCs you can find today! Capice?

Based on Intel®'s Pentium processor, all P5 models include a PCI local bus and an enhanced PCI/IDE controller allowing your hard drive to transfer data *up to twice as fast* as non-enhanced IDE systems. Gateway's P5-60 and P5-66 models, and our three power-packed **90MHz** models (*starting at just $2,995*), give you a value that towers over the competition!

Gateway's P5-90 machines use Intel's super 90MHz processor for foundation-shaking power. You get a rare combination of colossal power and performance, *and* a great price. Ah, magnifico! Just look at these features: performance-boosting 540MB hard drives, 8MB or 16MB RAM, double-speed CD-ROMs, high-end graphics controllers and your choice of application software. Two 90MHz systems also include 16-bit sound cards and Yamaha speakers. Go ahead and compare. You'll see that these value-packed PCs stand unmatched.

Get all the tools to create lasting impressions with any Gateway P5 system. Mama mia — starting from only $2,495, our Pentium values are out of this world!

Classic Attractions

Our 486 PCI machines are Gateway 2000 classics built on a solid foundation of performance and value. Our new **100MHz DX4** machine, priced at $2,495, is based on the fastest 486 processor available! With the same PCI local bus as in our P5 line, all 486 PCIs will give you a great power boost. They include 8MB RAM, 540MB hard drive and a double-speed CD-ROM drive. These 33MHz, 66MHz and 100MHz systems are all upgradable to Pentium technology so you can expand in the future.

Portable Sidekick
Special Offer!

A perfect sidekick for your Gateway desktop system is the HandBook® 486 portable PC. It's just like having an extension to your desktop system! Call about our special desktop/HandBook combo today, available only at the time of desktop purchase. Having all the information you rely on, everywhere you go, has never been so easy.

Gateway's P5-90 and P5-90 Tower systems rise above the competition!



intel inside

pentium PROCESSOR

GATEWAY2000

You've got a friend in the business.®

8 0 0 - 8 4 6 - 2 0 5 8

"A Gateway Portable

Heading out on another worldly expedition? Whether it's transcontinental or transatlantic, a Gateway portable PC puts you at the controls, steers you in the right direction and sends you flying!

GATEWAY2000
COLORBOOK™

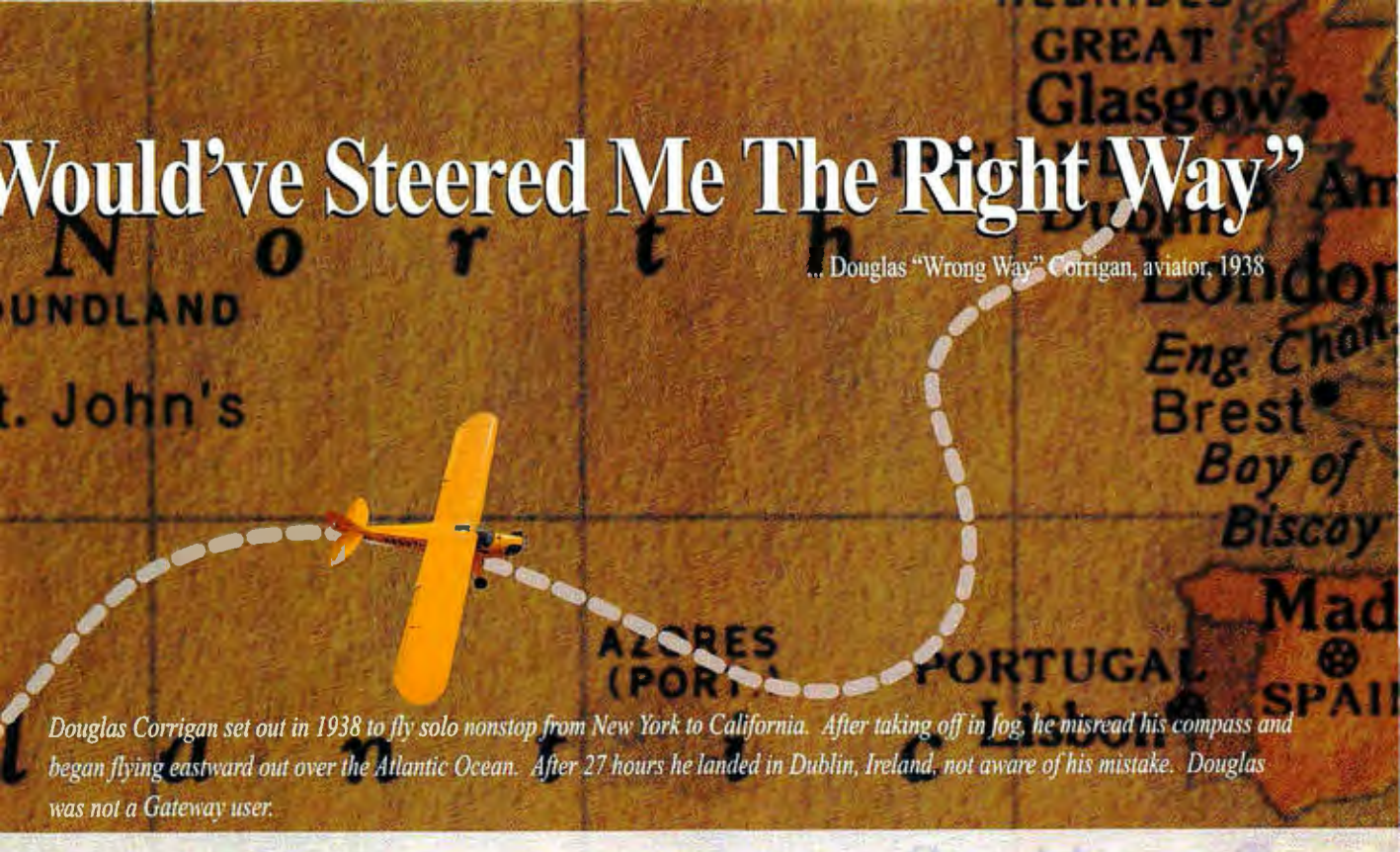
Flying Machines

How can you go wrong? You can't! A Gateway 2000® ColorBook is just what you need for high-in-the-sky performance.

A portable PC with the supersonic performance of a desktop is yours with the power-packed **DX4-75MHz** ColorBook. With a 75MHz processor, you'll never want to leave the ground without it. And look, over there! No, your eyes aren't deceiving you — that's a **10.3-inch, dual-scan screen,** now on *three* ColorBook models. You won't find a screen this big, this affordable, anywhere else. It blows the competition out of the water!

All ColorBook models are based on the Intel® SL Enhanced 486 DX2 or DX4 processor and have the power and memory to run all your Windows applications. Weighing in at less than 5.7 pounds, measuring 1.77-inches thin, these portables start at $1,995 and include 120MB or 250MB hard drive, support for simultaneous video, built-in trackball,

Do you know The way To San Jose?
New York 1238. I readed my
#900 airplane for The flight To
California. Everyone has a hobby
right? Little did I know my obsession
with refrigeration magnets would bring
a dark cloud of humidity down upon me.
I placed my collection of magnets all
around me. Ms. Piggy on The Throttle,
The Proton Salt od by The altimeter
and my favorite, The Flying right by
The compass — hundreds of magnets
all over The cramped cockpit
As I Took off into The wild blue
yonder, did I hear someone say Yipy
Dusbus, you're going The wrong way?
Ah. They mustVe said Yhave a nice day.
Ih been flying awhile when I looked
down and Thought - I knew Theyre called
The Great Lakes, but This is ridiculus
Is This compass right? I whacked it
a few Times, some of my dashboard
magnets fell on The floor.
My compass went crazy
until I put Them back in
place. Go figure. I
continued on Their what
was That? A whale in
Lake Superior?
Lord greeted me after
27 hours. Where's The
sun The beaches? I only
see redwoods and Lucky
Charms?
Darn Those refrigeration
magnets! Boy was The wife steamed
Hello, honey? Um... Ill be a little late
for dinner. I wish I would've had a
Gateway portable To keep me on course.



Would've Steered Me The Right Way"

... Douglas "Wrong Way" Corrigan, aviator, 1938

Douglas Corrigan set out in 1938 to fly solo nonstop from New York to California. After taking off in fog, he misread his compass and began flying eastward out over the Atlantic Ocean. After 27 hours he landed in Dublin, Ireland, not aware of his mistake. Douglas was not a Gateway user.

two PCMCIA Type II or one Type III slots, 256 colors running in VGA mode, excellent battery life, and a great suspend/resume feature.

You'll know you're headed in the right direction for top-flight performance when you get a Gateway ColorBook.

GATEWAY2000 HANDBOOK® 486

Take Flight!

It's so lightweight, you'll soar! So powerful, you'll be in awe! That's the HandBook 486 from Gateway 2000. Take flight with this compact little PC no matter where you go. Taking the world by storm with a footprint of just 9.75 inches by 5.9 inches, the HandBook 486 weighs in at (*are you sitting down?*) under three pounds! That's lighter than any Intel 486-based portable available today.

Still up in the air about the combination of portability and power? Head this way, because the HandBook 486 is a real PC and the only DX2 subnotebook found on any continent. No compromises here.

You'll get an IDE hard drive with up to 130MB, standard 4MB or 8MB RAM upgradable to 20MB, a backlit VGA screen, 78-key keyboard, EZ Point™ integrated pointer, and that terrific suspend/resume feature.

Whether you're a world traveler or an urban commuter, the Gateway 2000 ColorBook and HandBook offer you all the perks you deserve. So don't pick up the phone and go the "wrong way." Call Gateway 2000 straight-away!

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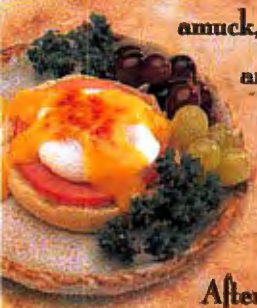
800-846-2058

"If I Only

Ever have one of those days? I was eating my Eggs Benedict when the wife looked up and snarled, 'You're not going to hang out with those friends of yours today, are you?' What did she mean by that? These were guys in togas, they didn't have much to hide.



But even the oracle told me not to go to work, 'You shall regret the company you keep.' What did that mean? After years of running amuck, conquering empires, and going on Roman holidays together, I felt I knew these guys.



After making a stop at the V and X cent store for eucalyptus lip balm, I continued on to the Senate house. Second mistake of the day. The first was getting out of bed.

Even as my last breath passed my lips, I wondered, 'WHY?' Death at the hands of my closest friends, then a salad and one of the hottest months of the year named after me. Hardly a fitting end for a man of my stature. Just goes to show no matter how much time you spend with guys in togas, you never really know them.

Man, I wish I would've had friends in the business.

Sometimes it's hard to know who to trust, especially in the competitive PC arena. You'll find our honest, hard-working employees to be allies, supporting villages and empires alike — wherever Gateway 2000® computers are found. Our loyal customers have helped us to become a Fortune 500 company, but we're not resting on these laurels. Every Gateway 2000 employee is committed to our philosophy of providing customers with a quality product at an unbeatable value, along with the best service in the land. You have our word on it.

Service Allies

As a Gateway 2000 customer, you receive toll-free technical support for the life of your system. And with the purchase of a Gateway modem you'll get Triton's CoSession™ Host at no additional charge. CoSession Host, a remote diagnostic software,

PORTABLES

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- Weight: 2.94 Lbs.
- Dimensions: 9.75" x 5.9" x 1.6"
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- 4MB or 8MB RAM (expands to 20MB)
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- 7.9" Backlit VGA Display
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- Suspend/Resume Feature
- 1 PCMCIA Type II Slot
- EZ Point™ Integrated Pointer
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HANDBOOK 486SX-25
With 25MHz 486SX CPU, 4MB RAM and 80MB Hard Drive
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- TelePath™ 14,400/14,400 fax/modem. **$249**
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With 75MHz DX4 CPU, 8MB RAM, 250MB Hard Drive and 10.3" LCD
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Peripherals and upgrades available only with purchase of a system.

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If a system comes with "choice of application software," choose one of the following packages:
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- Microsoft Word for Windows™
- Microsoft Word and Bookshelf,® CD-ROM Edition
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- Gateway Computer Glossary
- Gateway Mouse Pad

Systems with CD-ROM drives also include:
- Gateway System CD
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- Gateway Mall On-Line Catalog

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Every Gateway system is backed by:
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Our money-back guarantee does not include shipping. On-site service is provided at no charge during warranty if our technicians determine it is necessary. If you'd like to read our warranty and guarantee policies, please call for a free copy.

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Julius Caesar, Roman dictator, 44 B.C.

The Gateway 2000 Family PC™

Listen and watch legendary figures make speeches, or play interactive games, or get a jump on work from the office — all at home! For all ages, every day of the year, the Family PC from Gateway 2000 fits right into your lifestyle with full multimedia capabilities including sound, pictures, animation *and* video.

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Encarta gives you the complete text of the 29-volume 1992 Funk & Wagnall's New Encyclopedia. Discover a whole new universe with 25,000 articles, 350 music segments, over 100 readings by authors, and samples of more than 45 languages.

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These are just a few of the many possibilities of a Family PC from Gateway 2000. Call today for more information on these incredible systems.

Our Family PC comes with a 14-inch color SVGA monitor, 101-key keyboard, double-speed CD-ROM, sound card, speakers, joystick, fax/modem and mulitmedia software. You choose one software option from our great Family PC multi-title packages.

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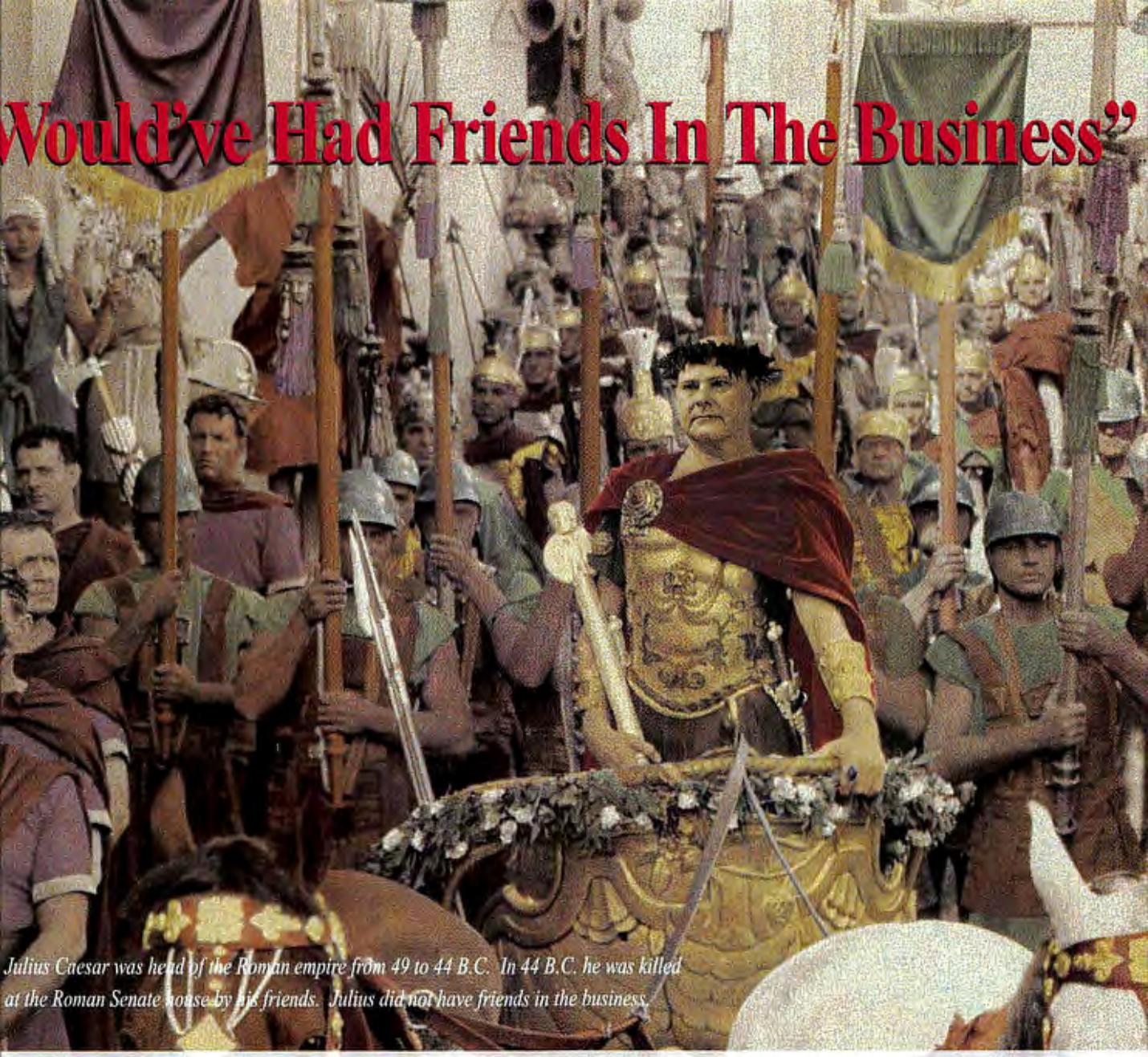


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8 0 0 - 8 4 6 - 2 0 5 8

Would've Had Friends In The Business"



Julius Caesar was head of the Roman empire from 49 to 44 B.C. In 44 B.C. he was killed at the Roman Senate house by his friends. Julius did not have friends in the business.

allows Gateway technical support representatives to troubleshoot your system on-line. They can also edit configuration files; run diagnostics; upload new drivers and files and, in most cases, install them for you

You also get a lifetime Gateway Bulletin Board System (BBS) membership with the purchase of a system and modem. This on-line service gives you a convenient way to communicate with us or with other users. On-line technical support, customer service and sales information are only some of the benefits of Gateway's BBS service. You can also download updated drivers, files and utilities for your Gateway PC through the BBS.

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Gateway accepts most major credit cards and C.O.D. terms, with net 30-day terms and leasing options available to qualified commercial customers. You can also apply for the Gateway 2000 DuoLine™ MasterCard® Card, issued by Dial National Bank. You can make purchases from Gateway and anywhere else MasterCard is accepted with two lines of credit — one for Gateway purchases and one for all other transactions. For Gateway purchases, the card has no annual fee and a low variable interest rate of just 12.9% APR. For other transactions, you get a variable interest rate of 13.9% APR and a low $18 annual fee.*



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Bonanno, "Wrong Way," and Julius all portrayed by Gateway 2000 employees.

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4SX-33*/4DX-33*

- Intel® 33MHz 486SX or DX CPU
- 4MB RAM
- 340MB 13ms IDE Hard Drive
- Local Bus Graphics with 1MB
- 3.5" Diskette Drive
- 14" Color CrystalScan® 1024NI
- Mini Desktop Case
- 5 16-Bit ISA Slots
- 101-Key Keyboard & MS Mouse
- MS-DOS® 6.2 & WFW™ 3.11
- MS Works for Windows™ 3.0
- EPA Energy Star Compliant

4SX-33 $1295
4DX-33 $1495

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- 14" Color SVGA Monitor
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- MS-DOS 6.2 & WFW 3.11
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- 3.5" Diskette Drive
- 14" Color SVGA Monitor
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- 5 16-Bit ISA Slots
- 101-Key Keyboard, MS Mouse & Joystick
- MS-DOS 6.2 & WFW 3.11
- Choice of Family PC Software
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SPECIAL OFFER!

Take advantage of our special offer on any HandBook® 486 portable PC when you buy a Gateway 2000 desktop system. Call your Gateway sales representative today for information on this Portable Sidekick offer!

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P4D-66*

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- 540MB 13ms IDE Hard Drive
- PCI Enhanced IDE Interface
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- Double-Speed CD-ROM
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- 15" Color CrystalScan Monitor
- Desktop Case
- 5 ISA, 2 PCI & PCI/ISA Slots
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- Choice of Application Software
- EPA Energy Star Compliant

$2295

P4D-100

- Intel 100MHz 486DX4 CPU
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- 3.5" Diskette Drive
- 15" Color CrystalScan Monitor
- Desktop Case
- 4 ISA, 2 PCI & 1 PCI/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software
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P5-60

- Intel 60MHz Pentium™ CPU
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- 540MB 13ms IDE Hard Drive
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- Desktop Case
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- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software

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PENTIUM SYSTEMS

P5-66

- Intel 66MHz Pentium CPU
- 8MB RAM, 256KB Cache
- 540MB 13ms IDE Hard Drive
- PCI Enhanced IDE Interface
- PCI Local Bus Graphics with 2MB
- Double-Speed CD-ROM
- 3.5" Diskette Drive
- 15" Color CrystalScan Monitor
- Desktop Case
- 4 ISA, 2 PCI & 1 PCI/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software

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P5-90 BEST BUY

- Intel 90MHz Pentium CPU
- 8MB RAM, 256KB Cache
- 540MB 13ms IDE Hard Drive
- PCI Enhanced IDE Interface
- PCI Local Bus Graphics with 2MB
- Double-Speed CD-ROM
- 3.5" Diskette Drive
- 15" Color CrystalScan Monitor
- Desktop Case
- 4 ISA, 2 PCI & 1 PCI/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software

$2995

P5-90

- Intel 90MHz Pentium CPU
- 16MB RAM, 256KB Cache
- 540MB 13ms IDE Hard Drive
- PCI Enhanced IDE Interface
- High-Performance PCI Local Bus Graphics with 2MB VRAM
- Double-Speed CD-ROM
- 16-Bit Sound Blaster-Compatible Sound Card & Yamaha Speakers
- 3.5" Diskette Drive
- 15" Color CrystalScan Monitor
- Desktop Case
- 4 ISA, 2 PCI & 1 PCI/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software

$3495

P5-90 TOWER

- Intel 90MHz Pentium CPU
- 16MB RAM, 256KB Cache
- 540MB 13ms IDE Hard Drive
- PCI Enhanced IDE Interface
- High-Performance PCI Local Bus Graphics with 2MB VRAM
- Double-Speed CD-ROM
- 16-Bit Sound Blaster-Compatible Sound Card & Yamaha Speakers
- 3.5" Diskette Drive
- 17" Color CrystalScan 1776LE
- Tower Case
- 4 ISA, 2 PCI & 1 PCI/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software

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* Intel Verified: for the Pentium™ OverDrive™ Processor

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Here's everything you need to add multimedia to a Gateway PC that has a CD-ROM drive:

- Gateway 2000 16-bit CD-quality sound card, compatible with Sound Blaster™ cards, with MIDI/game port, mic in, stereo line in/out
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- Microsoft® Encarta Multimedia Encyclopedia
- Corel Professional Photos CD Sampler

$132 *(with system purchase)*

Get the multimedia kit with a CD-ROM for **$299** *(with system purchase).*

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IBM® 16-bit ISA Token Ring card. **$429**

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Non-interlaced color monitor with intelligent multiscanning analog color display capable of ultra-high resolution up to 1280 x 1024 in non-interlaced mode and .26mm dot pitch.

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Affordable black-and-color printing. You get advanced color printing with built-in ColorSmart technology. 600 x 300 dpi and six built-in typefaces. **$599**

Epson ActionLaser 1500 Laser Printer

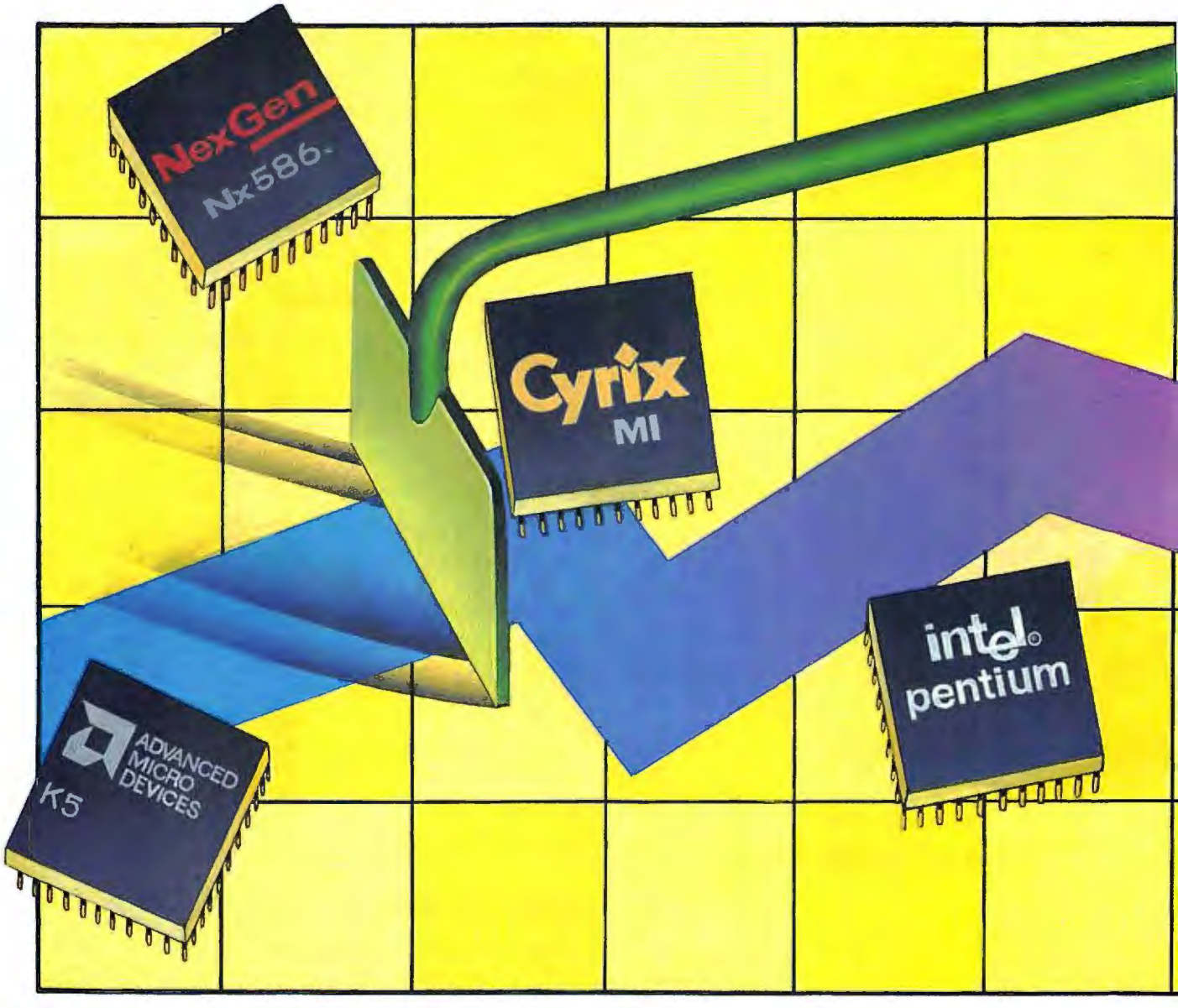
The ActionLaser delivers professional-quality printouts. Fast six-page per minute speed, 14 resident fonts, 300 x 300dpi, and 1MB memory expandable to 5MB. Parallel cable included. **$669**

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Cover Story

80x86 WARS



It's hard to accept the argument that the Intel 80x86 architecture or its underlying CISC technology is staggering on the brink of extinction. On the contrary, the next few years will see the broadest proliferation of the architecture since the 8086's debut in 1978.

TOM R. HALFHILL

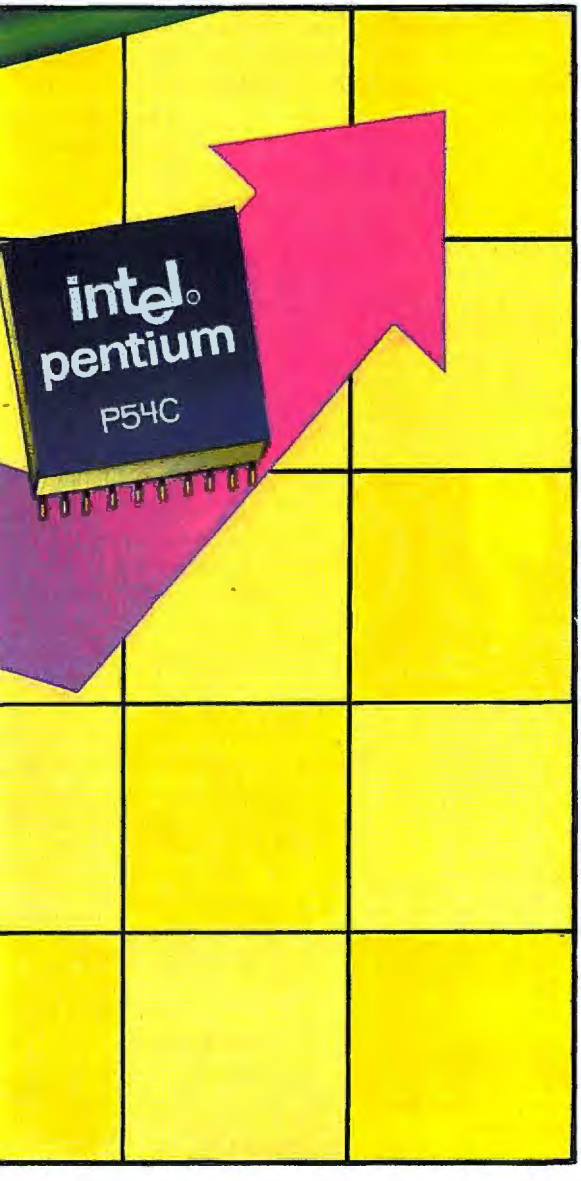


ILLUSTRATION: EARL KELENY © 1994

Apple is promoting its new Power Macs with charts that show CISC microprocessors sputtering out of gas while RISC chips like the PowerPC race up a steep curve toward superior performance. Actually, the leading CISC architecture—Intel's venerable 80x86—is on the verge of the greatest burst of evolution in its 16-year history. Over the next year, radical new designs from Intel and others will push the 80x86 to new heights of performance while challenging some popular assumptions about the differences between RISC and CISC.

At the same time, though, Intel will find its position as the leader in 80x86 technology increasingly under siege. Not that anyone will mount a serious threat to Intel's overwhelming market dominance; market-research firm Dataquest (San Jose, CA) estimates that Intel commands 74 percent of the worldwide microprocessor market, compared to a meager 8 percent for its nearest competitor Motorola. But until now, Intel alone has defined what is state of the art for an 80x86 microprocessor, and it has enjoyed a formidable technological lead of 12 to 24 months over its rivals.

That will begin to change this year, when competitors such as AMD (Sunnyvale, CA), Cyrix (Richardson, TX), and NexGen (Milpitas, CA) introduce new 80x86 processors that differ significantly from Intel's chips. These original, highly optimized designs promise to deliver better performance than Intel's Pentiums, while maintaining full compatibility with DOS and Windows software. In response, Intel is accelerating the development process and has separate teams of engineers working on the next two generations of its 80x86 simultaneously.

Then there are the wild cards. The 80x86 market is so lucrative—Intel is expected to sell more than 30 million 486 and Pentium chips this year—that it could attract even more competition from parties currently uncommitted. Texas Instruments (Dallas, TX), SGS-Thomson Microelectronics (Saint Genis, France), and IBM Microelectronics (Hopewell Junction, NY) make 486-compatible chips and have the expertise to produce fifth-generation processors but are coy about their future plans. While IBM is focused on making the PowerPC an 80x86 killer, it is also experimenting with the most exotic variant of the 80x86 yet conceived: a PowerPC with accelerated 80x86 emulation hardwired in silicon.

Although RISC chips like the PowerPC offer an approximate 2-to-1 price/performance advantage over the 80x86, that margin is not nearly as wide by the time the chips are packaged into finished systems. And it may not be enough to alter the path of an inertial PC market that historically values software compatibility and safe choices over raw speed and other factors.

For users, these trends have many implications—some good, some bad. On the positive side, you will enjoy many more options. Right now, however, your only choice is an Intel Pentium. Soon you'll be able to choose from a wide variety of PCs with comparable chips from AMD, Cyrix, and NexGen—the K5, M1, and Nx586, respectively. The extra competition is sure to force prices downward, and system vendors will welcome alternative sources of supply. Users who buy a 486 will benefit, too, as those prices drop under pressure from the higher-end chips.

There will also be more variety as the chip companies scramble to differentiate their products. New 486 and 586 processors are appearing in a wider range of clock speeds than ever before, making it easier to match the power of a system to your application and the price to your pocketbook. Different levels of CPU integration will offer still more options. NexGen's Nx586, for example, is really a 586SX, because the FPU is an optional coprocessor. Users who don't need maximum floating-point performance can save about $150.

The flip side is that more options mean more decisions, and some of those decisions will be more difficult to make. Already, some users have trouble understanding why a 25-MHz 486 is faster than a 33-MHz 386. In the near future, the diverging internal designs of 80x86

NexGen Nx586 Straddles the RISC/CISC Divide

BOB RYAN

First and foremost, the NexGen Nx586 is an 80x86 architecture processor; thus, it supports all 80x86 instructions and programmer-visible registers. Programs run on the Nx586 behave just as they do on an Intel 80x86 processor such as the 486 or the Pentium.

What differentiates the Nx586 is its microarchitecture. The instructions that are fetched from memory are standard 80x86 instructions, but the instructions executed in the processing pipelines are RISC-like translations of the CISC 80x86 instructions. NexGen calls them RISC86 instructions and uses them to give the Nx586 Pentium-class performance.

Every processor designer must weigh different trade-offs in deciding what functions to incorporate on-chip. NexGen's decisions regarding Nx586 differ significantly from Intel's decisions with the Pentium. The Nx586 contains three independent execution units—two integer and one address unit—but it does not contain an FPU. NexGen notes that everyone—including Intel—acknowledges that almost all 80x86 code is integer. Thus, NexGen devoted space on the die for split instruction and data caches that are twice as big as the Pentium's and for an integrated level 2 (or L2) cache controller, rather than for an FPU. The Nx587—a companion to the Nx586—provides hardware floating-point support on a separate chip.

The 32 KB of cache memory on-chip is divided into a 16-KB instruction cache and a 16-KB data cache. Both caches are four-way set-associative. In addition, the L2 cache controller supports a four-way organization. This relatively high level of set-associativity results in a higher hit rate on cache accesses. Unlike the primary caches, the secondary cache is unified.

The L2 cache controller communicates with the off-chip L2 cache via a dedicated L2 bus. This eliminates conflicts with the external address and data buses. The L2 cache is writeback, while the L1 caches are write-through. The write-through organization of the primary caches lets accesses to the primary and secondary caches occur in parallel. In the event of a miss in a primary cache, much of the secondary cache access has already completed in parallel.

Supporting an external bus, a separate L2 cache interface, and a dedicated FPU interface means that the Nx586 isn't pin-compatible with the Pentium. In fact, it requires a far bigger package—463 pins versus 296 for the P54C Pentium. In addition, the Nx586's external bus is incompatible with that of the Pentium and 486. The Nx586 requires dedicated logic to interface with standard AT systems logic. NexGen currently supplies a chip to support VL-Bus, with PCI (Peripheral Component Interconnect) support due later this year.

CISC into RISC

During processing, the Nx586 fetches CISC instructions from the instruction cache and stores them in its prefetch buffer. The buffer is divided into three parts, letting the Nx586 manage three different instruction streams at once. This helps keep the execution pipelines filled when the processor is executing instructions speculatively.

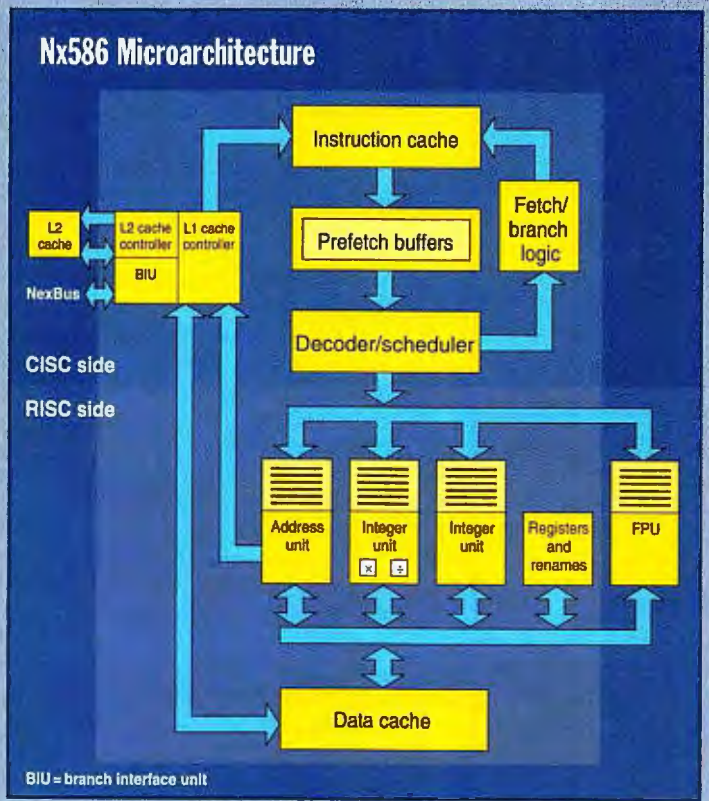
From prefetch, instructions move into the decoder/scheduler, where for every cycle, one CISC instruction is translated into one or more RISC86 instructions. Unlike CISC instructions, the RISC86 instructions implement a load/store memory-access model. Also, they are fixed-length instructions, as opposed to variable-length CISC instructions. However, they are significantly longer than standard 32-bit RISC instructions.

In fact, because they aren't designed to reside in memory, RISC86 instructions bear a strong resemblance to microcode. The major difference is that they are not as in tune with the hardware as is microcode. They are flexible enough to work without modification in both the Nx586 and in future versions of the microarchitecture that might contain a different mix of functional units. You might consider them "micro-architecture instructions."

The decode process translates one CISC instruction per clock cycle and dispatches the one or more resultant RISC86 instructions per clock cycle to the three execution units (four, if you have added an FPU to your machine). Therefore, while the Nx586 is a scalar processor from the CISC point of view, it is superscalar on the RISC side. The main limitation to instruction issue is that no more than one RISC86 instruction can issue to a particular execution unit per cycle.

The three execution units are different. One handles the generation of addresses for load/stores, while the other two handle integer instructions. One of the integer units has integral integer multiply and divide hardware, while the other can handle only simpler integer instructions.

Each execution unit, including the FPU, is fronted with a 14-entry instruction



The Nx586 combines a CISC front end with a RISC-like processing core. It employs dynamic branch prediction and speculative execution to keep its deep pipelines busy.

queue. All instructions must spend at least one cycle in the queue, even if the execution unit is not busy. Because of the variable length of time an instruction can wait in a queue, the pipelines themselves have an indeterminant depth. The shortest time from fetch to retirement is seven cycles.

Minimizing Penalties

Because the pipelines can get pretty long, the Nx586 devotes a lot of resources to minimizing conditions that can stall or flush them. It uses dynamic branch prediction and speculative execution to let execution continue before it knows the results of a conditional branch. It also uses register renaming and data forwarding to handle data dependencies within the pipelines.

The Nx586 uses 14 rename registers as destinations for writes to the 80x86 architectural registers, including the eight general-purpose registers. When a RISC86 instruction issues from the decoder/scheduler, it is assigned any required rename registers. When it is finally retired, it is allowed to update an architectural register.

The Nx586 fetches, decodes, and translates 80x86 instructions in order and issues RISC86 instructions in order. Instructions can execute and terminate out of order, but they are retired in order. The decoder/scheduler tracks instructions to ensure that they update architectural registers and trigger exceptions in program order.

The Nx586 is a fascinating design. It demonstrates that the 80x86 chip's microarchitecture hardly needs to resemble Intel's offerings. On a range of common benchmarks, it performed comparably to the Pentium. It might even presage some ideas that Intel has planned for the P6 and P7.

As a commercial product, however, the Nx586 has a way to go. It has garnered support from seven motherboard makers and four third-tier system vendors, but as of this writing, the lack of a definite fabrication agreement is troubling. The chip is priced competitively—$506 per chip in lots of one thousand for the 66-MHz version versus $750 per chip in lots of one thousand for the comparable Pentium (the Nx587 costs $128), and its functional mix should result in lower system prices. Overall, the Nx586 shows that NexGen can compete with Intel on the design side, but how NexGen plans to combat Intel's manufacturing muscle is still a mystery. ■

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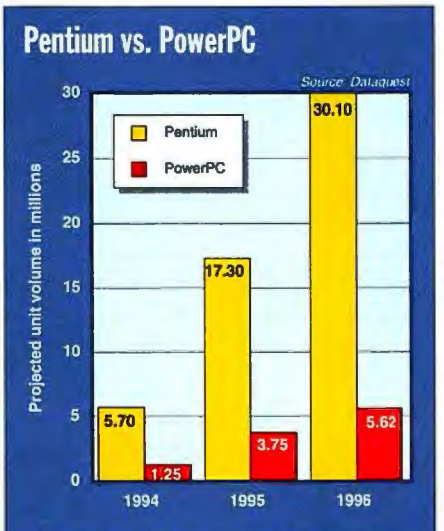
processors will mean that clock speeds are no longer a convenient shorthand method of comparing performance between different chips, even within the same generation. For instance, the performance of an AMD 100-MHz K5 may differ markedly from that of a Cyrix 100-MHz M1 or an Intel 100-MHz Pentium. The increasingly independent designs may also spur doubts about software compatibility.

Chasing the Pentium

The engineers at Intel have toiled to produce a new 80x86 generation at a remarkably predictable clock rate; roughly every 44 months since the introduction of the 8086. Performance has scaled at a similar rate. Now, like a clock-doubled CPU, Intel is quickening the pace. Its next generation, code-named P6, is scheduled to debut in 1995, a little more than two years after the Pentium, and the P7 is already in the works. Also, the Pentium team is still pushing the fifth generation with faster clock speeds, smaller process technologies, and higher levels of integration. The P54C 90- and 100-MHz Pentiums began shipping only a year after the 60- and 66-MHz Pentiums, adding new support for clock division, power management, and dualprocessing (see the text box "A Billion-Dollar Ball Game").

Intel is in a hurry because it's hearing footsteps. On one front, Intel is fending off the first credible RISC challenge in the PC market. Even though most observers don't view the PowerPC as a serious immediate threat to Intel's dominance—Dataquest projects the Pentium-class 80x86s will outsell the PowerPC by a ratio of about 5 to 1 through 1996—it nevertheless exposes a chink in Intel's armor. The PowerPC's current price/performance advantage may not be significant enough to woo the average PC user into switching platforms, but it makes Intel's technology look dated, and it could pose a danger if widened.

On another front, Intel faces renewed attacks from those who make 80x86-compatible processors that compete directly with Intel's chips. From a business standpoint, this competition has always been more serious because it vies for Intel's primary customers, the system vendors (see the text box "System Vendors Like Variety"). Now, however, the competition is heating up from a technological standpoint as well.



Although market-research firm Dataquest projects sales of about 5.6 million units for the PowerPC by 1996, it expects the Pentium to maintain an approximate 5-to-1 lead in sales with 30 million units sold.

Before the Pentium, the 80x86-compatible processors that AMD, Cyrix, and others made did not stray far from Intel's basic designs. For the sake of software compatibility, of course, they all had to share the same architecture: the instruction set, registers, condition flags, interfaces, and other characteristics that distinguish one type of microprocessor from another. But for the most part, they also conformed closely to Intel's microarchitecture—the internal details that distinguish individual chips within the same microprocessor family.

For instance, AMD's 386 and 486 chips use Intel microcode thanks to a cross-licensing agreement. (Intel has been fighting a losing court battle to negate those licenses.) IBM's 486 chips also use Intel microcode under similar agreements, but IBM is hampered by a proviso that limits it to selling chips on motherboards and subsystems, not as separate parts. Cyrix lacks a license to use Intel microcode, so it created a more independent microarchitecture but still didn't push the envelope beyond Intel's technology.

The Pentium, however, marks a fork in the road. For their fifth-generation processors, AMD, Cyrix, and NexGen are attempting to surpass the Pentium's performance with new microarchitectures that are less derivative. To maintain software compatibility, they will conform to the basic 80x86 architecture, but their internal designs will be increasingly independent. The development cycles for high-end microprocessors are too long for reverse engineering; thus, if they continue to let Intel define what is state of the art for an 80x86 chip, they will never close Intel's 12- to 24-month lead.

A similar situation prevailed in the early 1980s when IBM set the pace for PC systems. Clone

vendors generally followed IBM's lead until 1986, when Compaq brashly introduced a 386-based system before IBM. Soon afterward, IBM lost its position as the standard-bearer for the PC platform. AMD, Cyrix, and NexGen would like to pull the same switcheroo on Intel.

Borrowing from RISC

All three companies insist they can beat Intel at its own game. "When we started with the 386, we were five or six years behind," says Drew Dutton, strategic marketing manager of AMD's PC Products division. "With the 486, we were something like four years behind. The K5 will be about two years behind the Pentium, but closing the gap with the P54C and P6 is absolutely going to happen very shortly." More specifically, the K5 will deliver about 30 percent more performance than a Pentium at the same clock speed, says PC Products division vice president Robert McConnell.

Cyrix makes similar claims for its M1. "At introduction, M1 will be a technically superior product," says Steve Domenik, vice president of marketing. "The M1 will deliver more performance at the same clock speed. Based on simulations, it ranges from something like 30 percent to two times or even two-and-a-half times faster. Without [the software] running on silicon, it's hard to be too aggressive with those claims, but there's no question we'll have higher performance."

NexGen, the only Intel competitor that actually has silicon samples of its Pentium-class processor, claims the Nx586 will best an identically clocked Pentium, at least when running integer math. For example, NexGen says that at 60 MHz, the Nx586 measured performance gains of 8 percent with the Landmark 2.0 benchmark and 28 percent with the BYTE 2.4 benchmark. (BYTE was unable to independently verify NexGen's results in time for this story.) On the other hand, NexGen says the Nx586 obtained lower performance than a Pentium when running the PowerMeter 1.81 benchmark (–14 percent) and Norton Speed Index 7.0 (–7 percent).

Again, the reason why performance doesn't scale with clock speed across these competing chips is that they're using different microarchitectures. What the chips have in common, however, is that they're all adapting RISC technology to pump new life into a 16-year-old CISC architecture that 140 million PC users are loath to abandon.

The first hints of RISC technology began appearing in 80x86 processors in 1989, when Intel's 486 integrated an FPU, more hard-wired instruction logic, and pipelining. The FPU was Intel's first response to the superior floating-point performance of RISC chips. The additional instruction logic reduced the 486's reliance on microcode. And the 8-KB cache helped to keep

A Billion-Dollar Ball Game



There are three ways to make a faster microprocessor: increase the clock speed; design a better microarchitecture; or increase the transistor density. All these methods are interrelated, and each carries its own set of trade-offs.

Boosting the clock speed allows a CPU to process instructions more quickly, but it also requires more wattage, dissipates more heat, and increases the cost of other system components. Designing a better microarchitecture improves throughput, but it can take years of R&D. Also, it usually requires more logic, which increases the transistor count, enlarges the chip's die size, and hikes the manufacturing cost. Increasing the transistor density enables higher clock speeds and better microarchitectures, but it also dissipates more heat, unless the voltage is decreased to compensate. Lower voltages require system vendors to redesign their motherboards and chip vendors to redesign their peripheral components.

Microprocessor evolution typically follows this course: First, a better microarchitecture introduces a new generation of that CPU family. Later versions within that generation boost the clock speed and increase the transistor density (if not the actual transistor count) as smaller process technologies become available. Finally, when higher clock speeds and greater densities yield diminishing levels of return, the next-generation microarchitecture debuts, and the whole cycle starts over again.

Intel's 486 is a classic example. When introduced in 1989, the 486 offered a better scalar architecture than the 386, ran at 25 MHz, and was fabricated on a 1.0-micron process. Later, Intel shifted manufacturing to a denser 0.8-micron process and boosted clock speeds to 66 MHz. This year, Intel announced the 100-MHz IntelDX4 and moved production to a 0.6-micron line. Meanwhile, Intel also initiated another product cycle by introducing the next-generation Pentium.

This is a high-stakes game in which few companies are equipped to compete. A state-of-the-art, submicron fabrication plant (known as a *fab*) costs a billion dollars and takes years to build. Because a high-end microprocessor also takes years to develop, engineers have to target a fab process that isn't yet available. If everything does not come together at the right moment, the result can be financial disaster.

Some chip vendors dodge this problem by subcontracting all their fab work to outside suppliers. Cyrix and NexGen are "fabless" design houses that rely entirely on other semiconductor companies to manufacture chips. Cyrix now subcontracts its fab work to SGS-Thomson and IBM Microelectronics. The IBM deal, announced in April, should assure Cyrix's customers that supply will meet demand. In addition, it gives IBM the right to produce an equal number of Cyrix-designed chips (including the M1 and its successors) for use in its own systems or for sale to other system vendors.

Intel, AMD, and IBM Microelectronics have their own fabs, but they often fall short of demand. Intel and AMD are building new fabs, and AMD is also farming out work to DEC. Companies with excess capacity frequently make deals like this to recoup the huge costs of their fabs.

The capital investments for fabs are becoming so great that they almost dictate a semiconductor company's business strategy. In 1992, Intel ceded the still-healthy 386 market to AMD to produce more 486 chips, which command a higher price and are more profitable.

These business strategies should be kept in mind when comparing the price/performance ratios of competing microprocessors. For example, although RISC chips like the PowerPC 601 enjoy an approximate 2-to-1 price/performance advantage over the Pentium, it's not clear that it is entirely due to a corresponding difference in manufacturing costs. Both chips are now made on similar processes with similar transistor densities. Intel may simply be charging higher prices to amortize its capital investments more quickly. All semiconductor companies must play by the same basic rules of physics and finance.

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the 486's pipeline efficiently filled with instructions.

Pipelining is a key feature. It works like an automotive assembly line, substituting program instructions for cars. A pipeline has multiple stages, and instructions pass in lockstep from one stage to another. While some instructions are passing through the execution stages, following instructions can be moving through the fetch and decode stages. Once the pipeline starts flowing, the chip can process more instructions per clock cycle than a nonpipelined chip running at the same speed.

Pipelining and less microcode allow the 486 to process many of its instructions at an effective rate of one instruction per clock cycle, compared to a dozen or more clock cycles required by earlier 80x86 chips. (RISC chips achieve the same result partly by using simpler instructions that inherently require fewer clock cycles.)

Cyrix adapted some of these techniques to its 386-generation chips, creating 386/486 hybrids like the 486SLC. TI, under an agreement with Cyrix, introduced some 386/486 variants based on the Cyrix core. IBM's 486SLC2 is a similar crossbreed, combining a 486 pipeline and instruction set with a larger cache, a doubled clock, and a 386SX-style bus. But while IBM, Cyrix, TI, and AMD were still trying to match Intel's 486, Intel raised the bar again in 1993 with the Pentium.

Because the 486 is a scalar processor (i.e., single-pipelined), its theoretical throughput limit is one instruction per clock cycle. To break that barrier, Intel endowed the Pentium with two pipelines that can handle two instructions simultaneously. This allows the Pentium to issue some instructions at an effective rate greater than one per clock cycle, even though each instruction still requires at least one clock cycle to process.

Strictly speaking, this superscalar design is not part of the classic definition of RISC; some RISC processors, like the Mips R4000, don't have superscalar pipelines. But superscalar is generally lumped into the domain of RISC technology, because the complex nature of a CISC instruction set makes multiple pipelines difficult to implement.

For example, unlike RISC processors, which typically use 32-bit fixed-length instructions aligned on even-word boundaries, the 80x86 uses unaligned, variable-length instructions ranging from 8 to 120 bits. They are more troublesome to handle than are uniform RISC instructions, because the processor must decode their length before fetching the next instruction.

Self-modifying code and other stunts cause even more thorny problems when designing a superscalar 80x86. For instance, some programmers exploit the 80x86's irregular instruction format by writing code that executes in two different ways, depending on the fetch alignment. In other words, a byte that represents an operand field when fetched one way might be interpreted as an op code when fetched another way. Designing a superscalar 80x86 that won't choke on amusing little tricks like these is what makes CPU architects strangers to their families.

The superscalar Pentium successfully solves these problems and adopts a few other RISC-like features: a pipelined FPU with dedicated math logic; separate 8-KB instruction and data caches (compared to a unified 8-KB cache on the original 486); and a branch target buffer for branch prediction. The Pentium is really a hybrid CISC/RISC design that mocks the rivalry between these two philosophies and opens the door to further cross-pollination.

And that's exactly how AMD, Cyrix, and NexGen seek to leapfrog the Pentium; they intend to pick up where the Pentium leaves off. Cyrix, for example, is attacking another hoary CISC limitation: the register file. CISC processors typically have fewer GPRs (general-purpose registers) than RISC processors; in the case of the 80x86,

System Vendors Like Variety

System vendors and motherboard manufacturers will generally welcome the arrival of Pentium-class processors from AMD, Cyrix, and NexGen, even if some of them don't anticipate using any chips other than Intel's. They figure the extra competition will help drive down prices, ease supply shortages, open up new design options, and accelerate development.

Compaq (Houston, TX), currently the number-three system vendor behind Apple and IBM, says multiple sourcing is crucial to its goal of becoming number one by 1996. That's why Compaq recently signed a deal with AMD, even though Intel will remain its primary supplier of CPUs. Compaq is also a financial backer of NexGen, although no deal to use NexGen chips in Compaq systems has been announced.

"By working with Intel and AMD, which each have a different combination of price/performance in their products, we're better able to offer more choices to our customers to meet their needs," says John Sweney, Compaq's program manager for technical public relations. "For us, it's great to have relationships with both Intel and AMD."

Acer America (San Jose, CA) is another system vendor that relies primarily on Intel but also buys some CPUs from AMD. (Acer buys chips from Cyrix, too, but only for bare-bones motherboards sold to other vendors.) Acer has signed nondisclosure agreements to evaluate the forthcoming AMD K5 and Cyrix M1 processors, but it is concerned about how extensively its motherboards must be redesigned to accommodate the chips. "If the chip has a pin-out that's not compatible with Intel's, then it has to offer a strong price/performance advantage to make it worth our time to redesign," says John Chang, Acer's senior director of product marketing.

One solution is to design a motherboard that accepts a CPU daughtercard, allowing maximum flexibility. Properly designed, a CPU daughtercard won't impair performance, Chang says, but it adds to the cost of the motherboard.

Compaq, like Acer, makes all its own motherboards but is less concerned about minor differences among competing CPUs. "It doesn't impose any particular design issues for us because we're constantly redesigning our boards anyway," says Sweney. He notes that some of Compaq's motherboards are designed specifically for Intel chips, others will be designed for AMD chips, and some for either.

Micronics (Fremont, CA), a motherboard supplier that cranks out 40,000 to 50,000 boards a month, says it fine-tunes its designs to specific processors and buys Intel chips exclusively—however, that could change. "We still haven't had a compelling reason to jump ship," says Tom Benoit, corporate marketing manager at Micronics. "Would we? Yes. It would have to be something that offers better performance or more differentiation—and, of course, lower price. The PC market is a very price-sensitive market."

But price isn't everything. Benoit points out that even though he could probably get a better deal on Cyrix 486 chips right now, Cyrix uses a writeback cache instead of the write-through cache on Intel's 486. That would require Micronics to modify its motherboards, so it's easier to stick with Intel. "It's not as simple as who's got the cheapest part or who's got the fastest part," he says. "And there's something to be said for maintaining a relationship."

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- BYTE Magazine, January 1994 -

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there are only eight GPRs, compared to 32 in the PowerPC 601. But the Cyrix M1 will have 32 GPRs, using a technique called *dynamic register renaming*, which makes it appear as if there are only eight registers in use at a time, thus preserving compatibility with existing software that expects to see only eight registers.

The M1's superscalar pipelines will also be two stages longer than the Pentium's and will handle more instructions in parallel without stalling. The M1 also takes advantage of its larger register file to implement *speculative execution*, which allows the chip to continue to process instructions, with up to four levels of branching, without waiting for a branch to be resolved. If the branch prediction makes the wrong bet, *transparent repair* can back out of the speculative execution in a single cycle. In this respect, the M1 takes even greater pains than some RISC chips to keep its pipelines primed.

Fewer details are known about AMD's K5, but AMD promises it will borrow similar RISC-like techniques to achieve higher performance. "If you look back to around

BYTE Lab Benchmarks the First P54C Systems

RICK GREHAN AND SELINDA CHIQUOINE

The BYTE Lab received five beta P54C Pentium-based systems for preliminary testing. The systems included a Gateway P5-90, the Hewlett-Packard NetServer 5/90 LM, the HP Vectra XU 5/90C, the Intel Neptune, and the Intergraph TD-3. The Neptune was unique in that it housed a 100-MHz Pentium processor; the others used 90-MHz CPUs. The Intel machine is a development prototype and is not scheduled to be available for sale.

Although we would have preferred testing all machines under a single operating system, that was not to be. Three of the machines arrived configured with Windows NT 3.1, the remaining two—the Gateway and the Intel—were running Windows for Workgroups 3.11.

Since we were concentrating on the performance of the processor, we ran only BYTE's Portable benchmarks. We compiled the benchmarks using Watcom's 32-bit C++ compiler, setting the switches so that the output was optimized for the Pentium (as recommended by Watcom). Strictly speaking, this let us run the same *object* on all systems; the only difference was the link. For the NT systems, we created an NT character-mode executable file; for the Windows for Workgroups systems, we created a DOS extended-mode executable file (using the Rational Systems DOS Extender bundled with the Watcom compiler).

Most of the systems showed an improvement somewhere around two to just under two-and-a-half times that of a 66-MHz 486 (our baseline) for integer performance. Floating-point performance was better—somewhere between two-and-a-half to three times that of the baseline.

There were results of note that are not broken out in the table. First, the transcendental operations in the Pentium's integrated FPU show a significant performance improvement over their 486 counterparts. Second, the HP NetServer and Intergraph's TD-3 both turned in remarkable scores for those tests that were built around vector operations and therefore favored memory access that was sequential in nature. Those scores allowed the NetServer and TD-3 to surpass the Intel machine in the final index values, even though the Intel Neptune turned in better scores on all other tests. ■

Rick Grehan is the technical director for the BYTE Lab. Selinda Chiquoine is a BYTE Lab assistant. You can reach them on the Internet or BIX at rick_g@bix.com and schiquoine@bix.com, respectively.

Feature and Performance Comparison



GATEWAY P5-90



HP NETSERVER 5/90 LM



HP VECTRA XU 5/90C



INTEL NEPTUNE



INTERGRAPH TD-3

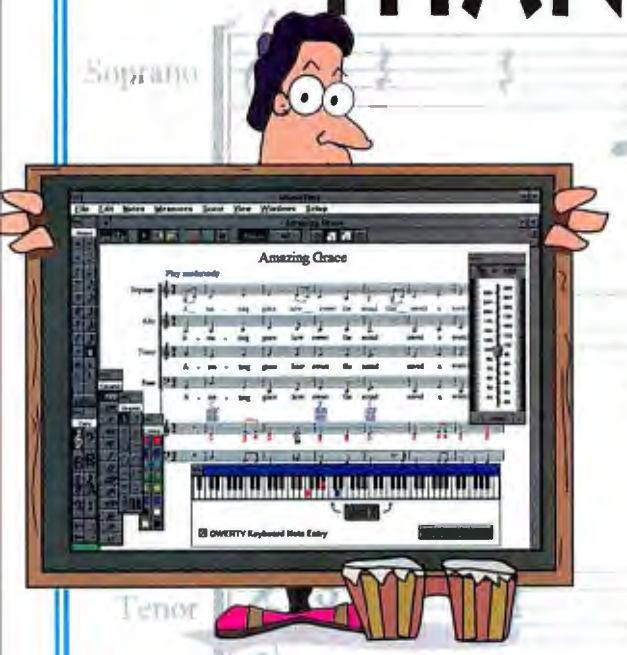
	GATEWAY P5-90	HP NETSERVER 5/90 LM	HP VECTRA XU 5/90C	INTEL NEPTUNE	INTERGRAPH TD-3
CPU/speed (MHz)	Pentium/90	Pentium/90	Pentium/90	Pentium/100	Pentium/90
Secondary cache (KB)	256	512	256	512	512
RAM (as tested, MB)	16	64	64	64	32
Memory width (bits)	32	32	64	64	64
Native operating system	Windows for Workgroups 3.11	Windows NT 3.1	Windows NT 3.1	Windows for Workgroups 3.11	Windows NT 3.1
Integer index[1]	1.89	2.42	2.02	2.25	2.37
Floating-point index[1]	2.46	3.3	2.61	2.9	3.12
System price (base configuration)	$3995	$7949	$5579	N/A[2]	$7300
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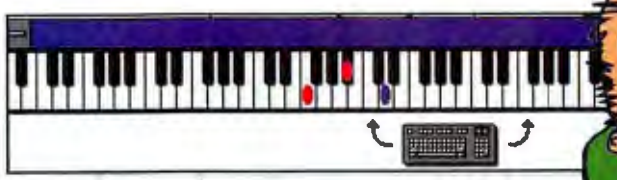


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1988, when we got into the RISC marketplace with the Am29000, RISC had a 5-to-1 advantage," says AMD's Dutton. "Now it's at best 2 to 1. That's going away. Both AMD and Intel and other 80x86 vendors are going to prove that." Significantly, the chief architect of AMD's K5 is Mike Johnson, who designed the Am29000 RISC chip and wrote *Superscalar Microprocessor Design* (Prentice-Hall, 1991), a seminal engineering book on superscalar RISC.

In a rare moment of Intel/AMD détente, Lew Paceley, marketing director for Intel's P6 division (Hillsboro, OR), agrees: "RISC is a technology; it's not an architecture. There's a difference. If it's a technology, everybody can exploit it. They may exploit it in slightly different ways, but the basic technology is available to everybody."

Reinventing the 80x86

NexGen's Nx586 appears to go even further toward the merger of RISC and CISC. It also hints at future possibilities for Intel's P6 and P7 chips, and may even foreshadow how the rumored PowerPC 615 will work its magic of emulating 80x86 code (see the text box "An 80x86-Compatible PowerPC?").

The Nx586 incorporates most of the RISC-like technology that suddenly is becoming standard in advanced 80x86 microarchitecture: long superscalar pipelines, wider data paths, on-board instruction/data caches (twice as large as the Pentium's), a larger register file with dynamic renaming, branch prediction, and speculative execution—with the enhanced ability to process streams of instructions nested three branches deep (see the text box "NexGen Nx586 Straddles the RISC/CISC Divide" on page 76).

What is most intriguing about the Nx586, however, is its unique decoder unit. In three stages, it fetches an 80x86 instruction, aligns it on an even boundary, and decodes it into one or more simpler instructions that belong to what NexGen calls the RISC86 instruction set. In other words, the decoder converts unaligned, variable-length CISC instructions into fully aligned, fixed-length RISC instructions that are pumped into the virtual equivalent of a RISC core. In effect, the Nx586 is a RISC chip with an 80x86 front end.

NexGen's RISC86 instruction set is optimized for 80x86 decoding. The decoder maps many of the simpler 80x86 instructions directly to their RISC86 counterparts, so a single CISC instruction is converted into a single RISC instruction. More complex 80x86 instructions must be decoded into multiple RISC instructions; NexGen says the worst case is a 3-to-1 ratio in the basic set of instructions. The decoder issues RISC86 instructions at a rate of one per clock cycle per execution unit.

In concept, the Nx586 decoder works like the code generator of a compiler, except at a lower level. Just as a C++ compiler converts C code into 80x86 machine code, the Nx586 decoder converts 80x86 machine code into RISC86 code.

Intel downplays NexGen's RISC86 and says the Pentium does something similar when it decodes complex 80x86 instructions into microcode primitives; in a sense, this is true. Complex instructions are broken down into 88-bit, fixed-length microinstructions that could be regarded as "RISC instructions," and many simple instructions don't require microcode at all because they're hard-wired in silicon. Intel also makes a valid point that code generators in modern compilers tend to avoid complex 80x86 instructions, because they can generate faster-running code by sticking to simpler instructions.

RISC86 instructions share some characteristics with Pentium microinstructions: They're quite long (the Nx586's eight-chip predecessor used 104-bit RISC86 instructions) and carry vital information of processor states that normally wouldn't be known to a true external RISC instruction. But there's still an important difference: Unlike microcode, NexGen's RISC86 can theoretically support its own assemblers, compilers, and application software. The Nx586 bus can bypass the 80x86 decoder and feed RISC86 instructions directly into the execution stages of the pipeline at full bus speeds. In fact, NexGen already has a RISC86 assembler, although it's for internal use only, since there's obviously no software market for RISC86 binaries.

But what if Intel introduced something like RISC86 in a future processor? NexGen, a small start-up company with zero market share, cannot hope that RISC86 will ever spawn its own software base. But Intel has considerably more influence. What if Intel defined a new 80x86 RISC instruction set and register file that coexisted with the CISC

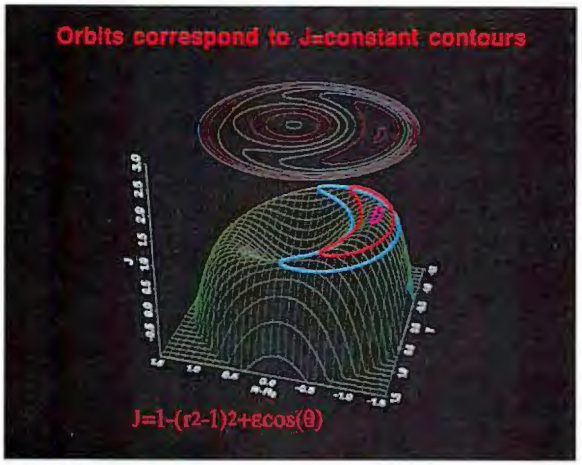
FIFTH-GENERATION 80x86 FEATURE COMPARISON

	INTEL PENTIUM	INTEL P54C	NEXGEN NX586	CYRIX M1	AMD K5
Superscalar micro-architecture	Two integer pipes, three execution units	Two integer pipes, three execution units	Two integer pipes, three execution units, and an optional FPU	Two integer pipes, four execution units	Unknown, but probably two integer pipes, at least three execution units
Pipelining	Five-stage integer pipes	Five-stage integer pipes	Variable-length integer pipes; seven-stage minimum	Seven-stage integer pipes	Unknown
FPU	Integrated and pipelined	Integrated and pipelined	Optional, not pipelined	Integrated, not pipelined	Unknown
Register file	Eight GPRs	Eight GPRs	22 GPRs with register renaming	32 GPRs with register renaming	Unknown
Branch prediction	Dynamic	Dynamic	Dynamic with speculative execution	Dynamic with speculative execution	Unknown
L1 cache	8-KB instruction, 8-KB data; two-way set-associative	8-KB instruction, 8-KB data; two-way set-associative	16-KB instruction, 16-KB data; four-way set-associative	Unified cache (probably 16 KB), with 256-byte instruction-line cache	Unknown
Clock speeds	60 or 66 MHz	90 or 100 MHz with clock-divided bus	60 or 66 MHz	90 or 100 MHz with clock-divided bus	Unknown, probably 60 to 100 MHz
Status	Shipped May 1993	Shipped March 1994	Sampling now, ships summer 1994	Late 1994	Late 1994

UNLEASH Your Pentium/486

The Pentium is the first x86 product in the last few years that bucks the trend away from faster PC numerics. It achieves improved speed by combining a CISC front end with an execution unit that uses RISC principles. This makes the Pentium sensitive to instruction scheduling. The Intel i860, which is the current leader in the embedded numerics field, can do up to two operations per cycle. While the Pentium can only do an operation every other cycle, this is much better than the 487, which can often take many cycles per operation. To help overcome the small 8 deep x87 numeric stack size, the Pentium makes it possible to exchange stack values at no cost. The machine code that results is difficult to read, but helps the Pentium run on a par with chips that have true numeric registers.

Microway's Pentium compilers take full advantage of the Pentium's dual numeric units using the same techniques we employ for the i860's dual units. Unlike integer programs, which benefit from the Pentium's Superscalar features, numeric-bound applications require a combination of instruction scheduling and loop unrolling to hit full speed. The Pentium code we produce for routines like DAXPY is virtually identical to the code recommended by Intel and better than the code we have seen in articles on the subject. The resulting programs run over a factor of two faster than older 16 and 32-bit compilers that do not feature register caching or loop unrolling. Call for our Pentium White Paper which compares the NDP family with other x86 Fortran and C|C++ compilers.



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instructions and supported its own native assemblers and compilers?

Linley Gwennap, editor in chief of the *Microprocessor Report* (Sebastopol, CA), thinks Intel might take this approach with the P7. "In this way, Intel will offer the performance of RISC while maintaining compatibility," he says. "And then, Intel might say to software developers, 'Oh, by the way, if you recompile using the new Intel instruction set, those applications would run really fast.' And other applications not converted [that is, still compiled for the CISC instruction set] would still run pretty fast."

Intel's Paceley says it isn't necessary to define a new RISC instruction set because today's compilers already strive to target a subset of 80x86 instructions that require fewer clock cycles. Interestingly, AMD's Johnson predicted this would happen three years ago in an appendix to his book on superscalar RISC design: "It should be possible to define a core set of [CISC] instructions that have at least some RISC-like qualities," Johnson wrote. "Once the data paths have been designed to execute these instructions in a single cycle, we are close to being able to apply the [superscalar RISC] techniques we have studied in this book."

Paceley hints that Intel will take another step in this direction by streamlining the instruction decoder in the P6. "Our architects know a lot about how to decode 80x86 instructions," he says. "They can figure out how to rip what would be this instruction decoder in a RISC machine and integrate it with the 80x86 decoder. Yeah, there's going to be a little microcode ROM off to the side to handle some strange cases, but by and large, anything that they're doing inside, we can do inside."

Whether Intel codifies a subset of RISC-like instructions or proffers a whole new instruction set, this trend strikes at the very heart of the remaining differences between RISC and CISC. To the extent that designers can minimize the decoding overhead and keep it transparent to the software, either approach could open broad new avenues for future 80x86 evolution.

Dangers of Divergence

As IBM, NexGen, Cyrix, and AMD keep pushing their microarchitectures along paths that increasingly diverge from Intel's and from each other's, it becomes more and more difficult to ensure that software will run exactly the same on everybody's chips. This burden is entirely borne by the chip vendors, of course; users and developers insist on absolute compatibility. Everyone admits the potential problem and agrees on the answer: rigorous compatibility testing that begins on simulators long before a new CPU is etched into silicon.

All the CPU vendors verify their new designs with extensive test suites that include real-world applications as well as special sequences of code that probe every known boundary condition. NexGen, as a newcomer, has more to prove, but the other companies have successfully navigated these waters for years. Everyone remembers what happened to the early system vendors whose PC clones were only 90 percent compatible.

Intel has no particular advantage here. Its processors are evolving in unforeseen directions, too, and must conform to the same software base. "Compatibility is defined by the software, not by the microarchitecture that existed yesterday," notes Peggy Herubin, director of applications engineering at Cyrix.

Another software issue, more related to performance than compatibility, is optimized compilation. This is one spin-off of RISC that 80x86 vendors would rather not deal with. RISC architects realized years ago they could reap even more performance if compilers were in tune with the chip's microarchitecture, especially in superscalar designs. Superscalar pipelines typically impose restrictions on the types of instructions they can process simultaneously. Careful instruction-ordering can maximize a pipeline's throughput.

For instance, the Pentium's twin pipes can work concurrently only on simple instructions. Typically, these are nonmicrocoded instructions requiring only one clock cycle. A smart compiler that strings a number of these instructions together while minimizing dependencies will generate up to 30 percent faster-running code. Intel recognized this when designing the Pentium and spent two years creating optimized code generators for license to vendors.

Software developers will not recompile their programs for every new 80x86 variant. Intel, as the market leader, theoretically enjoys an advantage, because the smaller companies have virtually no influence over developers.

The competitors don't see this as a problem. First, they point out that even a year after introduction, almost nobody optimizes their software for the Pentium. Indeed, even though it has been nine years since Intel introduced the 32-bit 386, almost all PC applications are still compiled to 16-bit code. Most DOS programs, such as Lotus 1-2-3 release 2.x and WordPerfect 5.1 Plus, are compiled for the first-generation 8086, because millions of XT-class machines are still in use. Some DOS programs, such as

An 80x86-Compatible PowerPC?

The most exotic application of CISC-to-RISC instruction translation might be IBM's rumored PowerPC 615 (IBM won't confirm or deny its existence). This chip could run 80x86 software using a sophisticated decoder similar to NexGen's, rather than the wasteful method of integrating an 80x86 core. Instead of decoding 80x86 into RISC86, however, it would convert 80x86 into native PowerPC instructions.

IBM already has this technology working in software. It's called the IST (Instruction-Set Translator), and it uses advanced code-analysis and caching techniques to convert 80x86 code into RISC code (see "Emulation: RISC's Secret Weapon," April BYTE). Implementing the IST in hardware could yield big performance gains and render the emulation so transparent that many users would mistake it for a native 80x86.

One source told BYTE that the IST front end might be implemented in a coprocessor chip, rather than integrated with the PowerPC. There are three reasons for this: (1) it would minimize the PowerPC's die size and reduce fabrication costs; (2) it would let system vendors offer models with or without the emulation coprocessor and perhaps let users add the chip later; and (3) if Intel sues IBM over the technology and wins an injunction, sales of motherboards with the empty socket could continue, and IBM wouldn't have to pull the CPU itself off the market.

Intel acknowledges that this approach to emulation could deliver near-native performance but adds that it might backfire on IBM if the performance is too good. Software developers might regard the PowerPC as just another 80x86-compatible chip and stop writing native PowerPC software. But one software developer dismissed this notion: "Even if we can get a 10 percent difference by going native, we'll go native," said Dennis Moore, director of product marketing at Oracle (Redwood Shores, CA). If IBM decides to introduce a chip like the PowerPC 615, it's expected to hit the market sometime in mid-1995.

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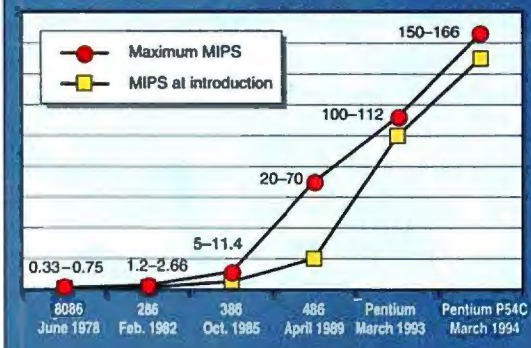
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80x86 Evolution: Performance



Since its introduction, the performance of the 80x86 architecture has scaled at a remarkably steady pace. The first 8086 was clocked at 5 MHz and executed about 330,000 instructions per second. The current top-of-the-line 80x86 is the new 100-MHz Pentium P54C, which is benchmarked at 166.3 MIPS. On the chart, the lower line measures performance of the fastest available 80x86 processor at introduction. The upper line shows the maximum available performance for each Intel generation.

80x86 Evolution: Transistor Density



Higher performance requires more logic circuitry, and this is reflected in the steadily rising transistor densities of 80x86 processors. While the number of transistors per chip has increased more than 100 times over the past 16 years, performance has increased more than 500 times. (Note: The latest P54C Pentiums have 3.3 million transistors due to additional integrated power management functions and an interrupt controller.)

Lotus 1-2-3 release 3.x and WordPerfect 6.0, are compiled for the 286. Some Windows programs are compiled for the 386. This probably won't change until Microsoft releases a 32-bit version of Windows, Intel sells more Pentiums, and developers overhaul their software.

In any case, developers favor a blended approach to optimization that is not closely tied to the Pentium's specific microarchitecture. In fact, it yields some gains on the 486 and 386 as well. "That kind of recompile is something that any superscalar architecture can take advantage of, so it doesn't hurt us at all," says AMD's Dutton.

More specific optimizations are possible but unlikely. It wouldn't even serve Intel's interests, because the P6 and P7 will have different microarchitectures than the Pentium. "Most of the compiler writers are doing generic optimizations," says Cyrix's Herubin. "Obviously, they don't want their compilers to only perform well on the Pentium. They want to perform well on the whole line of 80x86."

Benefits of Divergence

Although diverging microarchitectures pose some dangers, the reasons for pursuing them are simply too strong to ignore. First, the engineers need all the maneuvering room they can get for new designs that will boost performance. But also, the chip vendors need some way to differentiate their products. Paradoxically, their main selling point is that their chips are so compatible that users shouldn't notice any difference.

In the past, Intel's competitors have sought to distinguish themselves in three main ways: lower prices; continued production of chips that Intel is phasing out in favor of the next generation; and exploiting market niches that Intel ignores. For instance, when Intel shifted the bulk of its production from the 386 to the 486, there was still healthy demand for 386 chips. AMD and Cyrix did not have their 486 processors ready anyway, so they cleaned up after Intel by shipping huge volumes of the 386. Intel was willing to forsake the 386 at that point because prices had dropped very low and the 486 was more profitable. It will be interesting to see if AMD and Cyrix continue this strategy now that they're trying to leapfrog Intel's technology. Like Intel, they may find it more worthwhile to devote their expensive foundry capacity to leading-edge products.

Filling market niches is another traditional strategy of Intel's rivals. For example, Intel's fastest 386 is clocked at 33 MHz; AMD makes a 40-MHz chip. The fastest 486 was Intel's clock-doubled 33- and 66-MHz DX2 until IBM introduced its clock-tripled Blue Lightning 33/100. Intel offered no direct upgrade path from the 386 to the 486; Cyrix makes a 386/486 hybrid that's pin-compatible with 386 sockets.

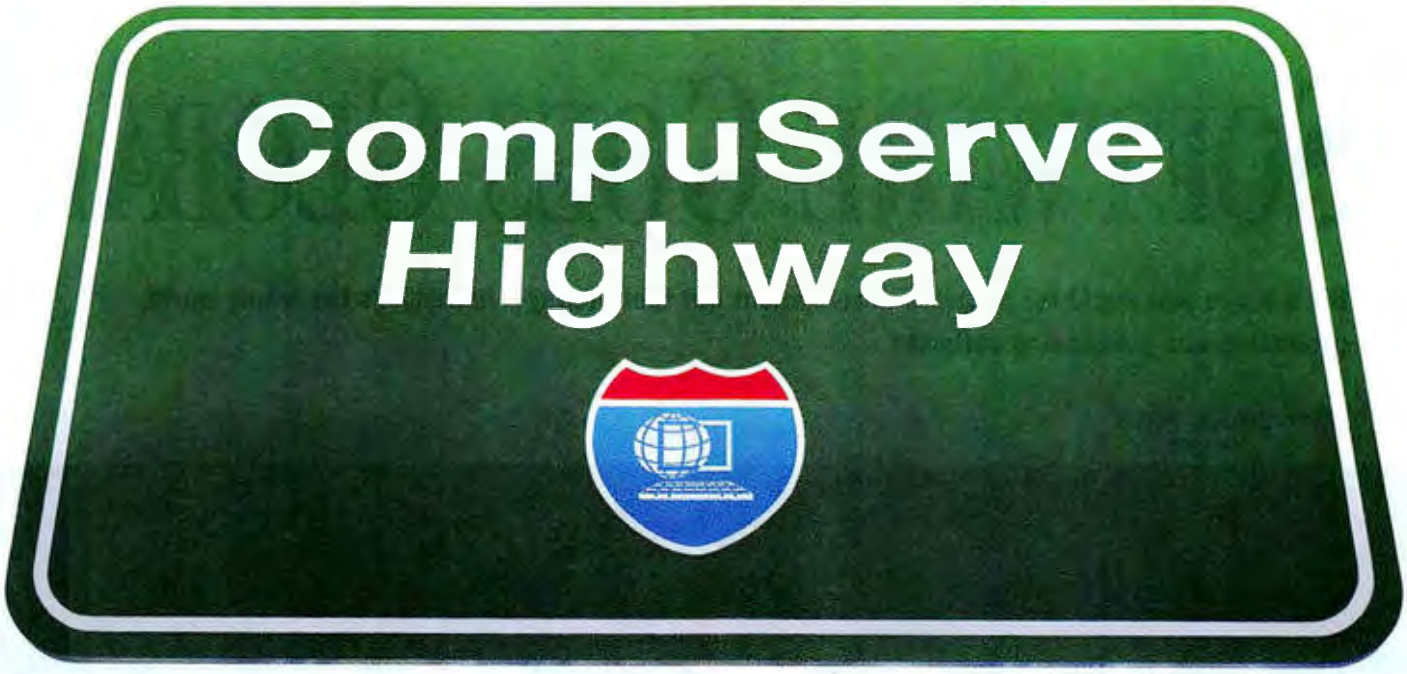
But Intel has caught on to this strategy. Over the past two years, it has introduced a much wider variety of 80x86 chips and is paying closer attention to holes in its product line. For instance, the recently shipped 100-MHz IntelDX4 neatly fills a performance gap between the 66-MHz 486DX2 and the 60-MHz Pentium. And Intel plans to offer a direct upgrade path from the 486 to the Pentium via the Pentium OverDrive Processor (code-named P24T), for which sockets already exist on many PC motherboards.

NexGen is boldly attempting to differentiate its Nx586 by offering the FPU as an optional coprocessor. This is an interesting experiment in reality engineering versus marketing hype, because NexGen must overcome a broad public perception that FPUs significantly improve the performance of spreadsheet programs and screen graphics. Everyone from Intel to the software developers agrees that floating-point performance is relatively unimportant for almost all PC applications, but many users simply won't buy a machine without an FPU.

NexGen's separate FPU notwithstanding, higher integration is a likely path toward future product differentiation. For instance, the Nx586 is the first 80x86 to integrate a level 2 cache controller, allowing the use of less-expensive SRAM (static RAM), while preserving high-speed access. The new 90- and 100-MHz Pentiums integrate an APIC (Advanced Programmable Interrupt Controller) for multiprocessing. DEC's Alpha 21066, although not an 80x86-compatible CPU, integrates a PCI (Personal Component Interconnect) controller and some video-control functions—a logical possibility for an 80x86. There's even serious speculation about integrating a DSP (digital signal processor) on an 80x86, perhaps with some hardware support for Microsoft's new DSP manager.

The inescapable conclusion is that the 80x86, ancient though it may be, is far from a dead architecture. It still attracts more engineering resources than any other CPU architecture that ever existed, and it's evolving in more lively directions than ever. In all likelihood, the 80x86 will continue to flourish until another architecture offers a wide enough price/performance margin to convince most users that it's time for a change. ■

Tom R. Halfhill is a BYTE senior news editor based in San Mateo, California. You can reach him on the Internet or BIX at thalfhill@bix.com.



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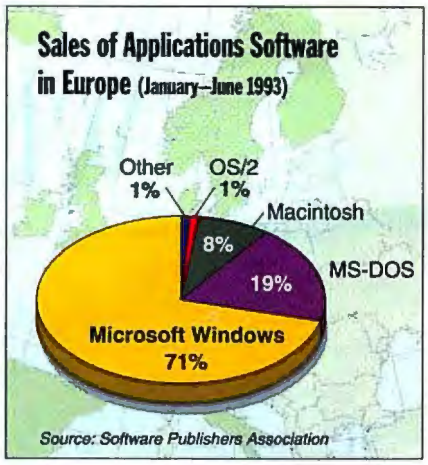
State of the Art

SOFTWARE GOES GLOBAL

It's a brave new world for software development out there today—in fact, it's the whole world, producing and purchasing software

RUSSELL KAY





It's easy to think of software as primarily an American thing: Most of it has been created and sold here, and here is where its future lies. Wanna bet?

The fact is, software today is a global affair. By some estimates, over 150 million computers are scattered around the world, and at least a third of these are located outside the U.S. All these computers, including those overseas, need software; this is a huge need that someone is going to fill, and it's a market that major software developers cannot afford to ignore. So it's hardly surprising that U.S. software developers are scrambling for a piece of the international pie.

At the same time, foreign software developers are having an increasing impact on the U.S. market. As a BYTE reader, it's a safe bet that you use many software products. It's likely that some of those products originate from a foreign source or that they incorporate significant code or technology that overseas developers created.

International sales make up more than half of the revenues for the top 100 U.S. software companies, according to the SPA (Software Publishers Association). Microsoft, for example, reported that in 1992, over half—55 percent—of its $3.2 billion revenues were earned outside the U.S. The SPA recently reported that in western Europe alone, 1993 sales of PC applications software amounted to $1.8 billion. While this represents an 11 percent growth in monetary value over 1992, it also represents a remarkable 75 percent growth in the number of units sold (see the figure "Sales of Applications Software in Europe").

The Cross-Cultural Blues

If you're developing software, you're familiar with having to design or implement for multiple hardware platforms and different operating systems. Now you're going to have to add yet a few more variables into the development mix. If you have any interest at all in the overseas markets—and you should—you need to consider how to modify your products to suit those foreign markets. As L. Chris Miller explains in "Transborder Tips and Traps," just taking care of the "mechanical" and top-level language differences is no simple task. Combine this with cultural differences (see "Crossing the Cultural Boundary"), and you begin to realize just how complex an undertaking it is to make software appealing and usable across international boundaries.

Programmers Here, There, and Everywhere

Yet marketing packaged software is only part of the story. Increasingly, programmers outside the country are developing software—even for U.S. companies. At the moment, there are two primary offshore sources for programming talent. One is Southeast Asia, including India, Singapore, and the Philippines in particular. All have relatively large numbers of skilled programmers available at wage levels that seriously undercut the American norms. In "Developing Software Overseas," Edward Yourdon describes the ways that foreign software developers are gaining a foothold in the American market and are competing successfully against the international software giants in their home countries.

Another important source for foreign programming is the countries of eastern Europe and the former Soviet Union. Russia, for example, has a pool of talent that, according to industry-observer Yourdon, is the equal of anything we can produce in the West. These folks are reportedly overjoyed to work for $200 to $300 per month, and they bring valuable contributions to the table. We ignore these programmers at our own peril.

Perhaps because the Russians were cut off from Western markets and practices for so long, perhaps because they have generally had to work on underpowered (by U.S. standards) equipment, or perhaps because they have a special talent for puzzle-thinking, Russian programmers seem to bring new insights and nontraditional ways of thinking to programming problems and models.

One small caveat may be in order. Americans shouldn't forget that a significant fraction of the world's computer viruses originated in eastern Europe, primarily Bulgaria and Russia. According to Vesselin Bontchev, a native Bulgarian and antivirus researcher at the University of Hamburg, Germany, these viruses were primarily the product of underemployed and undervalued programmers who found virus writing an interesting and amusing way to get back at the authorities. Let's hope that is behind them...and us.

What's Ahead?

Given the growing importance of the international market, you can expect to see publishers and developers place added emphasis on adapting their products—particularly new products that can start from a clean design and coding slate—to multiple languages and use in foreign countries.

So there's a lot at stake and a great deal to consider when you think about software as a global resource. The rest of this state-of-the-art section examines some of those considerations, discussing just what the internationalization of software means to the end user, to the software designer and coder, and to the marketer and publisher. ■

Russell Kay is a BYTE technical editor experienced in border crossings by virtue of having grown up on the Canada-U.S. border and later serving as a Peace Corps volunteer in Brazil. You can reach him on the Internet or BIX as russellk@bix.com.

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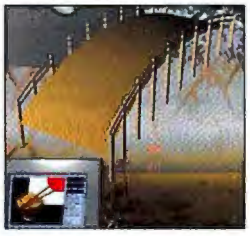




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TRANSBORDER TIPS AND TRAPS

Creating or retrofitting software for another country requires attention to myriad technical details involving language, translation, and interface

L. CHRIS MILLER



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There is no doubt that the U.S. dominates the world's software production—75 percent of currently installed packaged software worldwide is produced in the U.S. International sales make up half the revenues for the top 100 U.S. software companies.

International sales were responsible for 55 percent of Microsoft's $3.2 billion in revenues for fiscal year 1992. Ken Fowles, manager of global evangelism at Microsoft, reports that there is huge growth potential outside the U.S. for all Windows products. "Windows presently ships in 27 languages. All versions except Japanese will run using the U.S. version of DOS," he says. The Japanese version of Windows requires the Japanese version of DOS to support special hardware issues and incompatibilities specific to Japan.

The international software market is a multibillion dollar opportunity. The Software Publishers Association of Washington, D.C., reports that the four largest international markets for U.S. publishers are the U.K. and Ireland, Germany and Austria, France, and Japan. The U.S. has a 90 percent share of the U.K.'s $1.5 billion software market.

Definitions

Despite the continuing presence of American English versions of software products throughout the world, U.S. software publishers are responding to increasing international demand for software adapted for specific locales. The adaptation process is called *localization*, which is often abbreviated as *l10n*, because there are 10 letters between the letter *l* and the letter *n* in the word *localization*.

It takes a great deal of work to localize or retrofit a software package that was designed in American English to suit the requirements of another culture, language, or market. Some of the tasks involved in

localizing software include making code compatible with different formatting conventions; supporting local character sets; supporting local software and hardware; translating the interface (i.e., all screen displays visible to the end user, such as dialog boxes, prompts, menus, and error messages); translating all documentation (e.g., user manuals and warranty information); translating promotional literature, ad campaigns, and slogans; translating filenames; providing local customer service; and protecting product names and copyrights.

Localizing or retrofitting a product for another locale usually involves reengineering much of the underlying code. This is because software is not a static entity; it must act on data in accordance with the rules or conventions of a given locale. Reengineering the code for each locale is time-consuming and expensive.

Software companies are beginning to realize that tremendous savings and increased revenues are possible if the software is initially designed with features and code that are prepared to accept international conventions, foreign data, and format processing. Designing software that can provide the necessary support for the languages of the intended markets is called *internationalization*. Building internationalization (abbreviated as *i18n*) into a product minimizes or eliminates the need for engineering revisions and greatly simplifies the localization process.

Internationalization also reduces the time lags inherent in localizing software for multiple markets. Software developers have become sensitive to the issue of simultaneous release. Quark of Denver, Colorado, recently delayed the shipping date for its QuarkXPress 3.3 desktop publishing program to avoid compatibility problems for end users transferring files from U.S. companies to overseas offices. Multinational companies sharing files can appreciate this gesture. Another advantage to the simultaneous release of software in world markets is that it allows coordinated marketing campaigns.

Internationalization Approaches

Software developers generally use one of three approaches to isolate and protect the core algorithms:

Compile-Time Internationalization. Programmers change the files that contain the source code and algorithms.

Link-Time Internationalization. Programmers extract all the text strings, along with algorithms that are dependent on language or culture, from the program code.

Run-Time Internationalization. End users select locale. The software contains text files for more than one locale.

One interesting example of this last approach is embodied in Compaq Computer's Presario line of computers. The first time you boot up one of these systems, it asks you to choose the language you want to work in. However, if you inadvertently select the wrong one, you may be in trouble: The system automatically erases all supporting files for other languages. These files are the normal MS-DOS and Windows language-support files and could be easily restored from the distribution floppy disks, but Compaq doesn't supply the floppy disks with the machines.

Alphabet/Character Encoding and Unicode

Every language has its own alphabet or script; thus, alphabet or character encoding is fundamental to internationalizing software. Early computer standards for alphabet or script encoding made no provision for all the written languages of the world. Since computers manipulate numbers, text must be represented to the computer as a series of numbers, each number corresponding to a graphical representation of a character or glyph.

The most common coded character set is the ASCII 7-bit code set. ASCII supports 128 characters—52 uppercase and lowercase letters in the Roman alphabet and 10 numbers, as well as symbols, punctuation, a limited number of accents, and control codes. ASCII, one of the first code sets invented, was designed to support American English. Other coded character sets were created to support other languages.

Extended ASCII includes accented vowels like *á* and special characters such as the German *ß*. Windows uses a superset of the ANSI character set, essentially ISO 8859/x plus additional characters. The Latin-1 code set uses 8 bits (1 byte) to represent a character, which allows the representation of 256 characters.

Non-Roman languages with more than 256 characters use doublebyte, multibyte, or wide character sets. A doublebyte character uses 16 bits. A multibyte character set can mix single- and multibyte characters. A wide character set typically contains 16- or 32-bit characters.

Code sets differ across operating systems and language scripts. The best-known attempt to consolidate code sets is the Unicode standard. This character code standard, capable of encoding all known written languages, is being touted as the answer to efficient data portability among platforms. The Unicode Consortium, a nonprofit organization in Mountain View, California, was founded in 1991 to develop and promote the use of the Unicode standard. Charter members include Apple, Xerox, IBM, Microsoft, Sun Microsystems, and Novell. The ISO, based in Geneva, Switzerland, approved Unicode in June 1992 as the international character-encoding standard (ISO 10646).

Unicode is a 16-bit code set that can produce more than 65,536 characters. Of these, 34,168 places are defined for most characters used in writing systems, about 6300 places are reserved for software and hardware developers to assign their own characters and symbols, and 25,000 places are available for expansion. With Unicode, each character is allocated a unique 16-bit value or number. Each 16-bit number is called a *code point*.

Using the Unicode standard eliminates the need for complex modes or escape codes to specify modified characters or special cases. Another advantage is that Unicode has built-in special control characters for handling changes in text direction within a single line of text.

The increasing list of software products implementing Unicode is promising. Yet the cost of converting preexisting software to Unicode-compliant status is still prohibitive for several software developers.

continued

Levels of Internationalization

In his book *Solaris Internationalization Guide: Global Product Design* (Prentice-Hall, 1992), author Bill Tuthill characterizes software according to its level of internationalization on the following scale:

Level 1—Software with texts and code sets that are adaptable internationally or are considered "8-bit clean" and that support the Latin-1 code set.

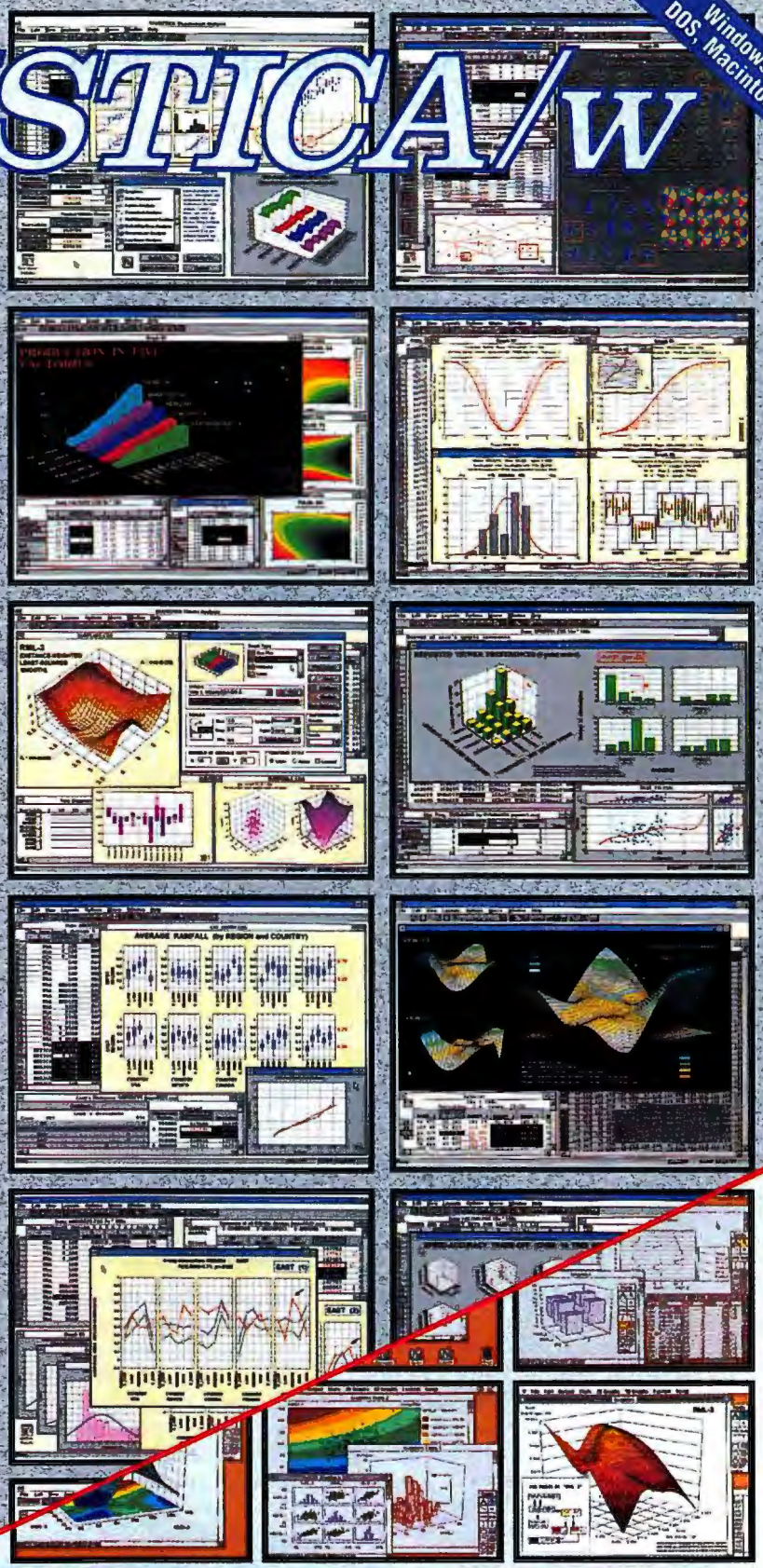
Level 2—Software with formatting and collation methods that are locale-sensitive. Includes sorting order for alphabets and formats for date, time, and so on.

Level 3—Software that allows easy translation of user-visible text, usually by placing such text into a separate file from the executable code.

Level 4—Software that supports East Asian languages, which frequently require multibyte code sets.

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Observing the Conventions

A considerable variety of typographic and local-usage differences have to do with the way people in different parts of the world use and express numbers, dates, quantities, symbols, and punctuation. The following short list shows some of the important conventions and format differences that you should be aware of:



Dates. May 12, 1959, would be written as 5/12/59 in the U.K., 12/5/59 in Denmark, and 1959-05-12 in Sweden.

Calendars. Most countries use the familiar Gregorian calendar. Israel uses the Gregorian and Hebrew calendars, while Arab countries use the Gregorian and Islamic calendars. In Japan, years can be counted by the Gregorian calendar or by the Japanese imperial era. Conversion options are included in localized software.

Time. A time denoted as 8:32 p.m. in the U.S. would be 20:32 in Canada, 20,32,00 in Switzerland, 20.32 Uhr in Germany, and KI 20.32 in Norway.

Numbers and Number Symbols. The U.S. uses a decimal point and separates thousands with a comma. Other countries use a decimal comma and a period, apostrophe, or blank space for the thousands separator. Thus 3,912.45 can become 3.912,45 or 3 912,45. Words used to express numerical quantities can have different meanings, too: A billion refers to a 1 followed by nine zeros in the U.S., while in Latin America and Europe, it refers to a 1 followed by 12 zeros. Therefore, a BBC announcer says "one-thousand-million dollars" where an American would say "one billion dollars." In Japan, software should support kanji, katakana, and Marusuuji (i.e., numbers in a circle), as well as the usual Arabic numerals.

Counting Currency. U.S. currency written as $2,456.78 is 2.456,78 DM in Germany and 2.456$78Esc. in Portugal. Also, don't forget the special characters needed for currency, such as the British pound (£) and the Japanese yen (¥).

Measurement Scales. Outside the U.S.—even just over the Canadian border—most countries use the metric system. Distances are expressed in kilometers instead of miles and in centimeters instead of inches.

Temperature. As with other metric-system units, references to temperature in most of the world are expressed in degrees Celsius, not Fahrenheit.

Paper Sizes. U.S. paper standards are letter, legal, and ledger. Almost everywhere else, the standards are A3, A4, and A5. Japanese paper sizes are JIS-B4 and JIS-B5.

Address Format. Americans generally place the house number before the street name. Most Latin Americans and Europeans write the street name first.

Punctuation. In Greek, interrogation is expressed not by our American English question mark but by what looks like our semicolon (;). Other punctuation marks include ¡ and ¿ in Spanish and « » for quotation marks in Greek and French.

Colors. Americans automatically associate red with "stop" and green with "go"; the Chinese do not.

Translation of Icons. Images do not always translate the way you expect. Apple's Trashcan icon, for example, looked like a postal box to British Macintosh users. Religious icons and hand gestures should be avoided, as they may have culturally insensitive meanings in a number of countries. If you use book icons, be sure they open in the proper direction for the target market.

Another problem area is program size—if every stored character is 2 bytes long, the software may require a significant amount of additional memory just to run. Thus, for a variety of reasons, it will be some time before international character encoding is standardized across platforms.

The Input Problem

So the software can deal with different character sets. But how do you get them into the computer? Keyboard drivers and mapping tables for a variety of code sets can contend with European and Asian languages. For example, French keyboards use an AZERTY keyboard rather than the QWERTY layout (the French just switched Q and W with A and Z).

Asian languages present the biggest challenge: entering non-Roman characters. The People's Republic of China's Hanzi ideographic script has over 7000 commonly used characters. (An ideographic character script uses pictures or symbols to depict a thing or an idea.) Taiwan's standards require 13,000 characters. The Windows 3.1 version for Taiwan supports six different input methods:

- *Chang Jei*—based on a public domain input method. Chinese characters are separated into two or more parts, or *radicals*. A radical is a part of a Chinese character that you can use to index the character; a character may contain more than one radical, but you can use only one of these as the indexing radical. These radicals are assigned to the keyboard letters *a* through *w* and *y*. The letter *x* is reserved for complex radicals, and *z* is used for selecting a duplicate word. Up to five keystrokes may be necessary to generate a single Chinese character.
- *Phonetic*—based on a phonetic alphabet (four different keyboard layouts are used). The keyboard includes 37 symbols representing consonants and semivowels and five for audible tones.
- *Quick/simplified*—a variation on the Chang Jei method.
- *Internal code*—based on the Big-5 internal code, which is an unofficial code page used in Taiwan that contains about 13,000 characters; this is enough for everyday business use but omits many classical Chinese characters.
- *DA-YI*—uses 40 defined basic radicals for character composition. This is currently the fastest input method found in Taiwan.
- *Array*—10 defined basic keystrokes (numbered 0 through 9). The keyboard is used as a matrix, and the number of basic keystrokes is the index of the matrix. Each Array radical on the keyboard is determined by the first stroke and the last stroke of the radical (i.e., the row index and the column index determine the radical on the matrix of the keyboard).

Software for Japan must support three distinct writing scripts. Text typically contains an average of 55 percent hiragana, 35 percent kanji, and 10 percent katakana.

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Hiragana uses 46 Japanese symbols (cursive script rather than block letter form) to represent all sound combinations. Kanji refers to more than 7000 Japanese ideographs based on Chinese characters. You can select one of two popular methods for inputting kanji characters: You can enter the hexadecimal representation corresponding to the character, or you can use a katakana-to-kanji conversion. If you type the phonetic spelling of the character, then the phonetic string is translated into the most-likely kanji character. A good converter should select the right choice about 80 percent of the time. When the translation is incorrect, you're presented with phonetically similar ideographs to select from. Katakana consists of 64 phonetic script characters and punctuation, used typically for foreign words. (Note: Hiragana and katakana together are often referred to as *kana*.) In addition, Arabic numerals and Roman letters are occasionally used in Japan for phonetic spelling of foreign words (these are called *romaji*).

A "real" Japanese keyboard commonly has 106 keys (versus 101 for typical U.S. keyboards). The extra keys are for toggling the Windows Input Method Editor, katakana-kanji conversion, and so on. On a U.S. keyboard, these functions are accessed by other key combinations.

Keyboard entry for Asian languages is understandably slow and tedious. Pen technology and handwriting recognition are being explored as possible solutions. There are already six pen-based Chinese character-recognition input devices available for Chinese Windows. Yet some ideographic characters are quite elaborate and require 12 pen strokes. Penkey (Orem, UT) sells a trainable print- and cursive-recognition system called Savant 2.0 that can handle many languages if the fonts are provided. Fonts for ANSI/Latin-1 languages and Japanese katakana and kanji come standard. The Savant 2.0 universal handwriting-recognition system includes built-in Unicode, JIS (Japan Industrial Standard), and ASCII switching.

In the future, voice-recognition technology will probably solve the laborious task of entering Asian languages via a keyboard. Dialects such as Mandarin (with 37 basic sounds, each with four possible inflections) are distinctly and carefully pronounced. Voice-recognition software is already dealing with intonation, pitch, inflection, stress, and pauses. The end user can modify pronunciation rules and exception dictionaries.

Fonts

Arabic is a calligraphic cursive script with 28 alphabetics, 10 numerals, and several special alphanumeric characters. Each Arabic letter has up to four possible shapes based on its position in a word: isolate, initial, medial, and final (i.e., alone, first, middle, and last). The software is expected to analyze the letter's position in a word and change the letter shape accordingly. About 250 characters are necessary to produce good-quality text. A DTP (desktop publishing) program might include up to 900 characters. One interesting feature of Arabic is that, while you are typing, previously entered letters will be changing shape.



Scott Meyer, XVT-Power++ Application Framework Software Developer.

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Transborder Tips and Traps

Sorting Sequences

Computer software for international markets must be able to implement various sorting algorithms. Each locale has its own sorting-order preference for uppercase and lowercase letters, double characters, accented vowels versus nonaccented vowels, and numerals.

In the U.S., for example, the sorting preference is from *a* to *z*; but in Denmark, there are letters after *z*. In Latin America, the double character *ch* is treated as a single character and is placed after *c* and before *d*. In Germany, *ö* sorts with the letter *o*; however, in Sweden, *ö* is the last letter of the alphabet.

Writing Direction

Most Western languages are written in a Roman script horizontally from left to right and continue this pattern from top to bottom. Arabic and Hebrew characters are written horizontally from right to left, from top to bottom—but with numerals going from left to right on the same line. Traditional Japanese characters were written vertically from top to bottom, from left to right. The Japanese language is now also written horizontally from left to right.

Interfaces and Menus

You must allow enough space for text expansion when translating from English into another language. The Microsoft Windows SDK (Software Development Kit) recommends allowing 200 percent extra space for 1 to 10 English characters, 100 percent extra space for 11 to 20 English characters, and 30 percent extra space for 71 or more English characters. For example, the Preferences selection from the Windows menu would translate as Bildschirmeinstellungen in German. Boxes containing text should be self-sizing and movable.

Remember that software may not run (or run properly) if text files do not strictly meet certain technical requirements, such as character-length restrictions, string files, line links, command prompts, and other source code variables. Internal calls to related files will fail if you change filenames. Terminology consistency is crucial, since there can be hundreds of cross-references between the interface, the documentation, the text files, and the filenames.

Translating Documentation

Special care must be taken with documentation translation. William Saiff, a technical writer in the Washington, D.C., metropolitan area, found an overwhelming need for guidelines to aid in the translation of technical and marketing materials. "Anything you do to make your information as clear and simple as possible promotes easier translation," he advises. "Avoid using English words with multiple meanings. For example, use *because* instead of *since*. *Because* has a single meaning; *since* can be confusing for a translator."

Terminology used in documentation should correspond to terminology in the software. Creating glossaries is important for maintaining consistent terminology. Microsoft publishes the *GUI Guide—International Terminology for the Windows Interface*, which includes standard translations for 14 European languages.

continued

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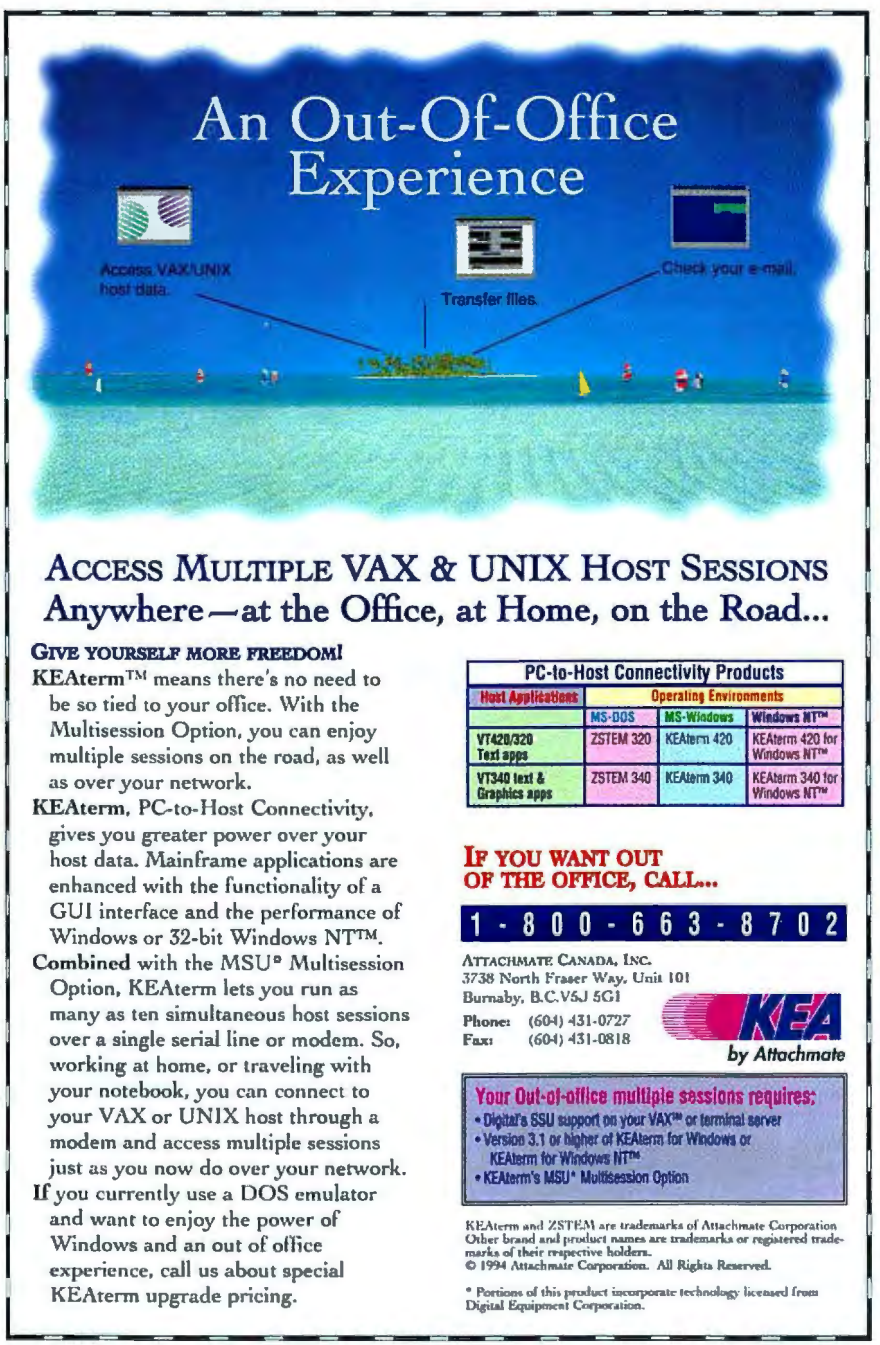
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Translation of Text Strings

Leave room on the disks or plan for extra disks to accommodate the increased length due to text expansion when translating from English into many non-English languages. File sizes of localized software will often be larger than the original English files. Also, be careful that file compression and decompression routines work properly with extended characters.

Translation and Terminology Tools

Many translation and terminology tools can accelerate the localization process. GlobalWare (Los Angeles, CA) offers three products for managing the translation process. These tools extract text from source code, formatting and hypertext codes, and document files. The translated text is then automatically returned to the correct locations in the source file.



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XL8 Code extracts text from programming code (e.g., C, C++, Windows resource files, Macintosh resource files, Lisp, and Pascal) by using filters or code-definition files. You can select the platform (e.g., Unix, DOS, Windows, Next, or OS/2) and the character-code page. XL8 Help processes Windows help files, while XL8 Text processes document files. Two important features are included in the three XL8 products: The glossary tool set lets you create a glossary and attach it to a file, and the leverage feature applies previous translations to the current file.

MCB Systems (San Diego, CA) markets the respected Trados line of translation tools. The Trados Translator's Workbench II is a translation editor that simultaneously accesses two databases: a terminology database, used to build custom glossaries, and a translation memory database that stores entire sentences as they are translated. This approach uses fuzzy logic to access previously translated terms and sentences, helping language professionals translate more efficiently and consistently. A *tag recognition* feature lets you localize files from various DTP programs, as well as from Windows Help and resource files. The Trados Translator's Workbench for Windows, expected later this year, will add a memory functionality to Word for Windows and WordPerfect for Windows.

WorldScript

Apple's WorldScript technology provides built-in enabling for most written languages. WorldScript was released as part of the System 7.1 operating system for the Macintosh in October 1992.

System-software support for language scripts is streamlined with WorldScript. Each language script affects components such as character encoding, keyboard layout, input methods, sorting, formats, and fonts. Tables in the system resources specify script behavior, while WorldScript I and WorldScript II extensions do the processing. WorldScript eliminates independent development for scripts. Routines for 1-byte languages are included with WorldScript I. WorldScript II extensions provide routines for 2-byte languages. Support is included for right-to-left scripts, vertical scripts, in-line conversion, and third-party front-end processors.

Using the set of APIs along with a supporting language module eliminates the need for a specific foreign-language operating system. Programmers can now write their software for a single operating

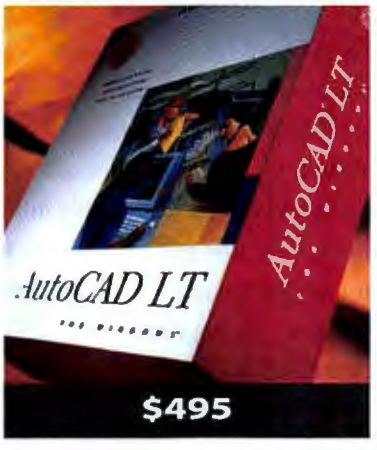
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system. Mac applications can be quickly localized, even for non-Roman languages. Apple intends to support Unicode in future releases of its system software.

Multilingual Software

The software industry is looking toward creating software designed to serve several markets without the need for localization. Such software is sometimes referred to as *multilingual software*. An early example was the 8/24 GC graphics card driver developed at Apple. The driver included all the strings needed for 14 languages in a single piece of software, automatically configuring itself for the language of the user by checking for the language in which the operating system was running.

Gamma Productions (Santa Monica, CA) offers a complete Unicode-compliant multilingual word processing and font system for over 100 languages. Universe for Windows 1.04 permits mixing any combination of languages supported. It is even possible to mix vertical and horizontal scripts (e.g., Chinese and English) with correct rotation of characters and punctuation. Checking the spelling of multiple languages is possible in one pass.

Tools to Support Software Migration

The Gamma Server for Unicode is a 32-bit DLL that provides a systemwide set of resources for integrating multilingual processing in any Windows 3.1 or NT application for single-byte and dual-byte languages specified by Unicode. By using Gamma's API, an application can access a host of language-based services, including a wide variety of keyboard layouts; methods for converting user input to Unicode data; text services for determining character properties, contextual analysis, ligatures and font mappings; plus spelling checker, hyphenation, and thesaurus support.

Multilingual Computing Magazine and Buyer's Guide (Sandpoint, ID) offers information on the technical aspects of internationalization. The magazine covers new technologies, services for companies interested in localization, reviews of software tools and publications, and a calendar of events. Also, it has an extensive list of multilingual computing products.

The promise of expanding international markets with generally higher profit margins is motivating U.S. software developers to internationalize or localize their products. Developers considering foreign markets need to know that much more than translation is involved. Two excellent reference books that offer detailed overviews are *Global Software: Developing Applications for the International Market* by Dave Taylor (Springer-Verlag, 1992) and *Software Internationalization and Localization: An Introduction* by Emmanuel Uren, Robert Howard, and Tiziana Perinotti (Van Nostrand Reinhold, 1993). U.S. software companies will continue to maintain or gain a competitive advantage by adapting their products to meet the unique requirements of foreign countries. ■

L. Chris Miller, a computer consultant in Washington, D.C., has been involved in machine translation and software localization for many years. You can reach her on the Internet at 70303.314@compuserve.com or on BIX c/o "editors."

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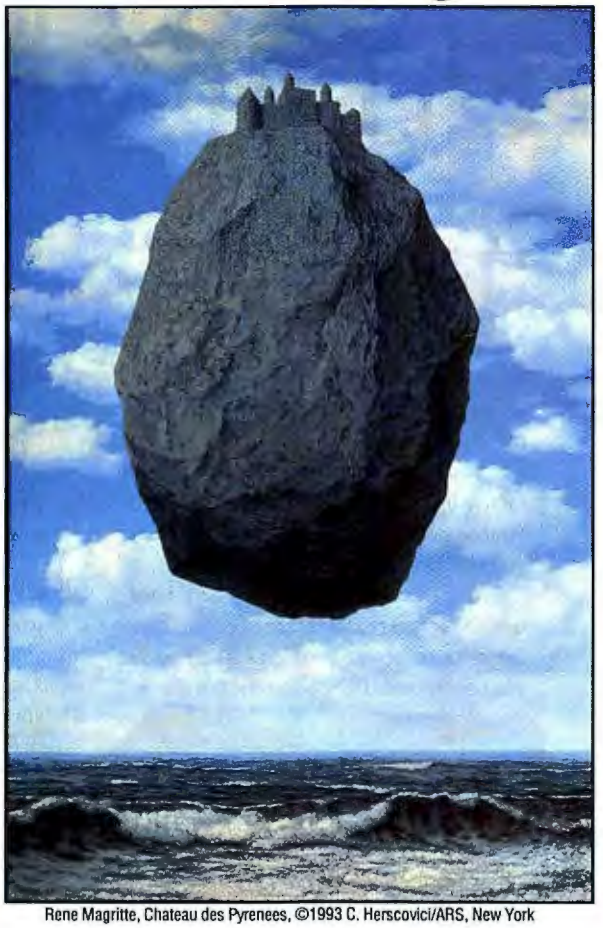
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Andrew Wargo, Manager at Baxter Land Company, tried two other brands before Back-UPS. "One lasted a few days, a second one went up in smoke after 48 hours, a third lasted less than 24 hours! I then bought my Back-UPS for less than half of what I had paid for the others. We've purchased three more Back-UPS and for the past 14 months they've been just hummin' away on the same power line that was eating the other brands alive!"

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CROSSING THE CULTURAL BOUNDARY

Designing software for a different culture calls for an awareness of its subtleties and unwritten assumptions. Japan is a case in point.

KUMIYO NAKAKOJI



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Suppose you're a software developer with a groupware product that you have successfully marketed in the U.S. Now, you are about to introduce it to the Japanese market, and you have done your international-trade homework. You have solved complicated legal issues and determined that there are no competitive products available in Japan yet. You have embedded a kana-kanji conversion package into your package's interface and rewritten your system to deal with 2-byte character sets. You enlarged the size of the product's text window by shrinking menu bars on the display, because they would need twice as much data due to the 2-byte code. You hired a professional translator to translate system help messages, the user's manual, and other documentation into Japanese.

Yet in spite of all this careful preparation, there is still considerable potential for failure, almost none of it easy to foresee without taking extraordinary measures. This article points out some of the hidden assumptions and built-in misunderstandings that must be ironed out when taking a software system across a cultural border. The examples focus on differences between the American and Japanese cultures, but striking differences can exist for many other cultural pairs.

First, the people who translate the manuals have very little knowledge of or user experience with groupware tools; the resulting manuals are difficult for foreign speakers to understand. Special terms may be literally or inadequately translated—it would not be unusual for *groupware* to be translated into "a device for a crowd"; the appropriate translation in Japanese is the same word, *groupware*, spelled out phonetically in kana characters. For a long time, Americans poked fun at the awkward locutions of "Japanglish" once found in manuals for consumer-electronic equipment; the lesson should be clear for those wishing to translate in the opposite direction.

continued

State of the Art Crossing the Cultural Boundary

The idea of freely typing opinions into your groupware system on-the-fly during a meeting in Japan would not work because converting kana characters (which can be input by using a conventional Latin-alphabet keyboard) into kanji is a very tedious task. By the time you finish typing a Japanese sentence, the topic is probably not being discussed any more. Also, you should not have sacrificed the menu-bar space for the text window because Japanese expressions are, in general, much more concise than English ones. A typical paragraph translated into Japanese takes only 60 percent to 70 percent of the space used by English.

Finally, and perhaps the most important difference of all, the role and concept of a meeting is totally different in Japanese business. Brainstorming discussions are held after work, often in a social setting over drinks. Negotiations must be done prior to the meeting. During the actual meeting time at the workplace, people just agree with whatever their managers describe and propose. It is considered socially unacceptable to challenge your manager's ideas in public. In summary, there is no point in using your groupware tool to record decisions made during a meeting. Indeed, there may be no point in using your product at all in the Japanese setting.

To deal with these difficulties, guidelines and checklists have been proposed for introducing systems into other cultures and adjusting surface-level interface designs, including text and formats of numbers, dates, and time. Interface designers should also be aware that different cultures have different connotations of images, symbols, and colors, and may require quite different mappings between the logical flow of ideas and the physical flow of objects on the screen (see reference 1). See "Transborder Tips and Traps" on page 93 for discussion of some of these factors.

Underlying, Unwritten Assumptions

However, such surface-level adjustment is not enough. The introduction of software to a new culture brings to light many hidden and unpredictable factors. A system's functionality is often unconsciously affected by underlying traditions of the culture in which the system is designed.

For example, many of the fundamental concepts used in Western-language word processors—such notions as cursors, tabs, and margins—stem from the typewriter culture. The typical user of a Japanese word processor has had little exposure to the typewriter, because BC (before computer) documents were formatted using writing pads that typically used a 20-by-20 grid for each character. To judge the length of a document in Japanese, we count characters instead of words. Given this background, Japanese users have had a considerable amount of trouble understanding the concepts of cursor movement embodied in a typical word processor application.

Many of the fundamental concepts used in Western-language word processors—such notions as cursors, tabs, and margins—stem from the typewriter culture. But the typical user of a Japanese word processor has had little or no exposure to the typewriter.



Reasoning processes and perceptions toward computer tools also vary from culture to culture. Germanic people prefer precise queries, whereas Latin people prefer browsing. A trial-and-error method is perceived as tedious and time-consuming in Japan, whereas some cultures associate the method with freedom and exploration, giving it positive connotations. American users view CASE tools as drawing and writing tools, whereas European users view CASE products as analysis tools. These factors should be taken into account in designing the functionality of a system, as well as in development processes, marketing, and installation of the system.

Resources

One research effort addressing cross-cultural considerations in human-computer interaction design is exemplified in two recent workshops in cross-cultural perspectives on human-computer interaction held in association with CHI (Human Factors in Computer Systems) conferences. The first workshop, held in Monterey, California, in 1992, explored how the science and practice of human-computer interaction research can support people working together by effectively dealing with and possibly taking advantage of the diversity of their professional and cultural backgrounds (see reference 2). The second workshop was held in Amsterdam, The Netherlands, in 1993 to further develop a conceptual map of the cross-cultural perspectives on human-computer interaction and to identify guidelines for developing cross-cultural design artifacts (see reference 3).

Modeling Cultural Differences

During the second workshop, participants discussed a model (based on Trompenaar's model introduced by David Gee of the East London Business School) to characterize cultural differences more systematically. The model includes six different aspects, many representing a polarity or a spectrum of behaviors and assumptions. Each of these aspects has significant implications for interface design.

Time Perception. In some cultures, people prefer processing jobs in parallel, while in other cultures, the preferences is for sequential operation. People's attitudes toward patience is another issue. In some cultures, fast service is important and considered a sign of efficiency; in others, people may prefer friendly but slow service, feeling that fast service is cold and rude.

Individualism vs. Collective Action. Some cultures value teamwork, while others value individualism.

Procedural vs. Declarative. In Western culture, people tend to prefer descriptions written in a declarative manner, while in Oriental and Russian cultures, people prefer descriptions to be written in a procedural manner. For example, a paragraph in English often begins with a summary sentence, followed by auxiliary reasoning. In Japanese, however, a summary sentence usually comes only at the end of each paragraph, following step-by-step reasoning. These different writing styles should be taken into account in designing help messages and on-line manuals, as well as marketing and advertising material.

Universalistic vs. Particularistic. Some cultures value uniformity and want to have a uniform, global mechanism for performing multiple tasks. Others value particularism and prefer to have a different system specifically tailored to each task.

Internal Control vs. External Control. In Western cultures, individuals want to have control over their own environment (e.g., Western

medicine tries to conquer an illness). In the Oriental culture, on the other hand, individuals try to harmonize with the existing environment by gradually adapting to it (e.g., Oriental medicine tries to compromise and harmonize with nature). Such characteristics determine whether users like to have active or passive control in the human-computer interaction.

Communication Overlaps. When two people communicate, the interaction between them and the way they take turns depends on their language and culture. In many Western languages, the two parties take turns, alternating back and forth. In Asian languages, the parties also alternate, but each alternation is followed by a brief pause. In Latin languages, the two sides of the conversation are likely to overlap, so that one interferes with the other. This may need to be taken into account when considering human-computer interaction as communication.

Although this list is not exhaustive, consideration of these aspects can help software designers to internationalize their systems.

Crossing the Barriers

With such a model as a framework, the challenge is how to identify and understand those characteristics. This challenge raises issues discussed in the first cross-cultural workshop mentioned above: You have to work with people from different cultures. Communicating with people from different cultures is much harder than expected. Not only are there language barriers but also the lack of mutually understood social norms, background, and context require time, effort, and patience to establish a shared understanding. For example, if Japanese test users said they liked your system, would you know whether they were telling the truth or just being too polite to make negative comments about the system?

Talking to people who know both cultures (e.g., a Japanese person who has lived in the West for a number of years) would be helpful, but it is also important to note that such a person represents, in fact, yet another culture: a culture on a boundary. Such a person may have slightly different value-judgment and reasoning schemes from foreign users who have not lived in other cultures.

In addition to nationalities, you can characterize culture by differences in language, race, age, gender, or geographical region. Also, the introduction of computer systems creates additional new cultures: Consider the differences in what is expected of a computer interface between a Macintosh user and a Unix user. Different disciplines, different expertise levels, and different roles in the workplace (e.g., managers, developers, and end users) each form their own culture. And each of these cultures is "not explicit but implicit, hidden behind or in the various artifacts, symbols, work routines, and established patterns of cooperation" (see reference 4). These considerations make you believe that adjusting your system to a culture by changing only surface-level issues will not work.

To successfully introduce your software system to a different culture, you first need to familiarize yourself with the target culture, and then you should design what amounts to a completely new system for that culture. Obviously, you want to identify reusable components from the original system and retain as many as possible, but you must recognize that some major changes may be needed before you build it. Most important, keep an open mind—you will probably learn a lot about both the culture and your system after you introduce the system into the culture and get feedback from local users. ■

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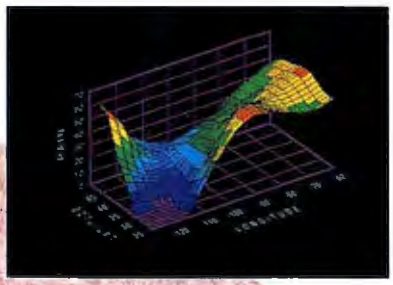
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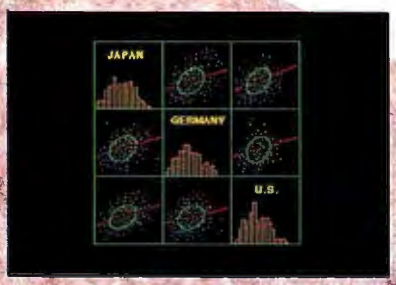
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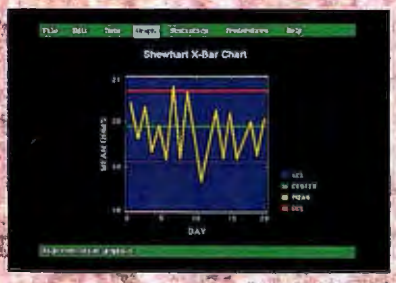
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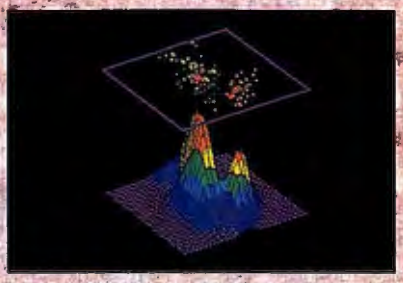
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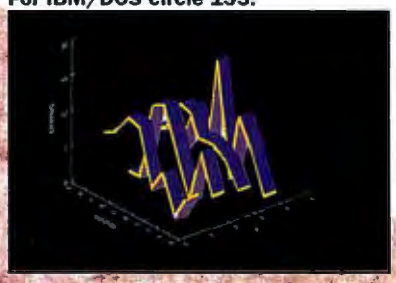
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DEVELOPING SOFTWARE OVERSEAS

Around the world, local developers are creating software that's as good as or better than anything being made in the U.S. Here's a look at the way the offshore software industry is growing.

EDWARD YOURDON



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About six years ago, I began warning people that the American software industry was likely to face increasing competition from developing nations. That warning has been borne out. Offshore software producers are grabbing a noticeable chunk of the global software pie. While the U.S. still dominates the industry, over the next few years, you can expect an increased presence of non-U.S.-made software in both domestic and international markets. And a number of these products will come not from the industrialized nations of western Europe but from third-world developing countries. The leaders in this movement will be countries such as India, Singapore, the Philippines, and Russia, where labor costs are low, and skilled programmers are abundant (see the text box "Quality: The Hidden Offshore Advantage").

We can expect the world's developing countries in particular to take a clear path with regard to software development. This path has four distinct stages, and each stage offers some interesting opportunities.

Stage 1: Live-in Contract Programmers

At first, teams of third-world programmers will be knocking on doors, offering to develop software with teams located at the customer's local site. The primary advantage to this approach is low price. Even with the overhead of travel, lodging, and administrative expenses, the client often finds that he or she is paying only half the cost of a comparable American work force. In some cases, cost is not as important as availability. If the project involves a "hot" technology (e.g., using Visual Basic for a client/server application), it may be difficult for the client to find available talent in the normal labor pool. There is also the issue of stability: The "body shops" that provide offshore programmers often argue that their people are less likely to quit and take another job in the middle of a critical project.

continued

Quality: The Hidden Offshore Advantage

American programmers are grappling with 20-year-old legacy systems that were estimated at 81 billion lines of COBOL a few years ago. The programmer from India has no such problems. Our industry is now saddled with hundreds of thousands of programmers who know COBOL but not C++, MVS but not Unix, and structured design but not object-oriented design.

I should emphasize that programmers from India, Singapore, or China are usually just as well educated as their counterparts in Silicon Valley. The university computer-science curriculum is adequate in many developing countries—and if it's not, students simply go to advanced countries for their education. Indeed, approximately 50 percent of the graduate-level computer-science students in the U.S. today are foreign nationals. Most of these students learn English as a second language and can read the latest computer literature with ease.

Thus, the best software teams in the developing countries are just as good as the best software teams in Germany, France, and the U.S. For example, the Software Engineering Institute, an American research organization, rates the capability of a software organization to consistently produce high-quality software at specific levels ranging from 1 to 5. Approximately 80 percent of U.S. and European organizations are at level 1, which is the bottom of the scale, 10 percent are at level 2, and a small percentage are at level 3. Only a handful of organizations are at level 4 or 5. According to a report in *The New York Times* (December 29, 1993), a Motorola software team in Bangalore, India, was recently given a level 5 assessment; what makes this particularly interesting is that no other Motorola software group, anywhere in the world, has yet achieved this rating. See the text box "Software Process Maturity Scale."

Most of the problems associated with the first stage of development within the software industry are obvious: The overhead expenses reduce the competitive advantage of lower salaries, without providing any benefit to the client or the software vendor. Visas and work permits can involve enormous red tape, and the delays may be unacceptable to a client with a tight deadline. Language problems, cultural differences, and the difficulty of trying to maintain a life-style comparable to the higher-paid U.S. colleagues with whom the foreign programmer is working—all these are obvious but predictable problems. Similarly, the client will often express strong hesitation about hiring a foreign programmer without an on-site interview; this poses a financial risk for either the overseas vendor or the client, depending on who pays the travel costs.

A more subtle problem involves the "brain drain" from the foreign country. In the long run, perhaps the U.S. should rejoice in the fact that its software industry is becoming a "melting pot," just as its manufacturing industries did throughout the nineteenth century. But national planners in the developing countries are very concerned: They are losing their best and brightest minds, because many of the programmers who go to the U.S. for a software project never come home. (Ironically, one government study in the Philippines actually encouraged this practice, because expatriate workers typically send home a steady stream of cash to their relatives. This was judged to be a more effective way of bringing hard currency into the country than such traditional mechanisms as building a factory.)

Stage 2: On-site Analysis, Offshore Code

The second stage involves having a small group of systems analysts who will work with the customer, on-site, to define the system requirements, which they then transmit back to programmers in the home country. Most of the first-stage offshore players are planning to move in this direction. Using a small number of on-site analysts saves considerable transportation and overhead costs. Having home-country software engineers implement the design also minimizes the brain-drain problem and allows the offshore software firm to begin building its own infrastructure and long-term expertise in software technologies.

The problems and disadvantages of the second developmental stage are obvious: End users are reluctant to trust an offshore firm several thousand miles away with the development of a mission-critical system. It's often not clear to the customer whether the software developers will understand the nuances of his or her requirements, nor is it clear how well the developers can respond to ongoing changes in those requirements.

Most developing countries have a mediocre telecommunications infrastructure, compounded by bureaucracies that Americans would find mind-boggling. For example, when I recently tried to establish E-mail communication with a colleague in India, my colleague apologized for the delay caused by the need to file government applications and obtain permits—just to get an E-mail address on someone else's Internet node. In theory, modern technology allows easy fax and E-mail communication from New York to Bangalore just as it does from Bangalore to New York; however, in practice, it doesn't always turn out that way.

The second stage, however, isn't an all-or-nothing proposition: It works in some instances, not in others. It's particularly good for certain kinds of systems programming projects, where the interface and the end results are well understood and clearly defined. For example, a software engineer who's building a C++ compiler for yet another Unix hardware box doesn't need much communication with the programmers who will be the product's end users. This explains why many U.S. hardware and software companies are heavy users of second-stage software organizations. Also, if you're part of a multinational company that has already dealt with the telecommunications issues for its overseas operations (e.g., Andersen Consulting, which recently established an office in Manila), you probably won't encounter many new problems when you farm out some of your software projects.

continued

Growth Stages for Foreign Software Industries

1. **Foreign programmers develop software with teams located at the customer's local site.**
2. **A small group of on-site systems analysts works with the customer to define a project's system requirements, which they then transmit to programmers in their home country for implementation and coding.**
3. **Overseas developers create generic software products that can be marketed both in the home country and in the advanced countries.**
4. **Overseas software producers offer to the world products that take advantage of specialized knowledge and unique areas of expertise in their native countries.**



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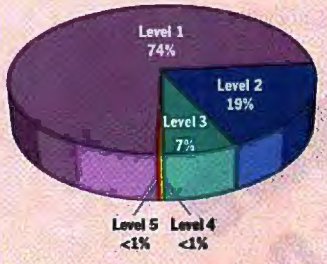
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Software Process Maturity Scale



Designed to rate the capability of a software organization to consistently produce high-quality software, the figures below show the percentage of software-producing organizations that have achieved a given level.

Level 1: Initial—The ability to complete the project

Level 2: Repeatable—Good project organization/planning, testing, and quality assurance; configuration management issues in hand

Level 3: Defined—A standardized development process across the organization; intergroup control; peer review/walk-throughs; and proactive training programs to improve human skills to meet the organization's needs

Level 4: Managed—A solid metrics program in place; the ability to quantify the process; the ability to establish and meet benchmarks

Level 5: Optimizing—Pulling all the pieces together; reacting to changes and proactively anticipating problems; the ability to use numerical metrics to feed back into the process; and continuous improvement based on experience

Source: Software Engineering Institute

Within Motorola—a company where quality is taken seriously—the only software organization to achieve level 5 on the SEI scale is in Bangalore, India.

And if your users and developers are accustomed to working with a rigorous software methodology that CASE tools support, you can reduce the communications problems substantially. The Pact Group, a company based in Lyons, France, has taken this approach. It works with European clients and documents user requirements in a KnowledgeWare ADW CASE tool. The ADW repository is then shipped to Manila, where a "software factory" of Filipino programmers, each equipped with a personal KnowledgeWare CASE tool, carries out the design, implementation, and testing.

Stage 3: Offshore Generic Software

The third stage in the growth of the offshore software industry is the development of generic software products—such as word processing packages, spreadsheets, and database programs—that can be marketed both in the home country and in the rest of the world.

This stage often begins with the offshore software developers producing software for their local markets. This is possible because off-the-shelf American software may be unsuitable for a variety of reasons. The American software giants might consider the software market in Uruguay, for example, too small to bother with. Also, senior managers at Microsoft have told me that a new product doesn't even show up as a "blip" in the accounting system until it generates $50 million in annual revenues; but this would represent a phenomenal success for a software producer in many developing countries, who would be happy with even a small fraction of that amount. Similarly, American software producers might ignore Brazil because of problems with government bureaucracy or concerns about rampant piracy. They may have ignored North African and Middle Eastern countries for political reasons or because they couldn't or wouldn't cope with the difficulties of Arabic script.

American-made software can pose other, more subtle problems once it crosses the border. Standard, shrink-wrapped PC software packages from software giants like Lotus and Microsoft are intended primarily for operation on American-built hardware boxes by English-speaking programmers. No matter what vendors tell you about their support for non-English languages and less-common PC clones, programmers in developing countries such as Mexico, Brazil, and Chile find the reality quite different; they talked to me at length about their problems getting "standard" software (e.g., word processors or spreadsheets) working on their machines. Sometimes the problem was with the hardware or the operating system, and sometimes it was with the foreign-language dictionary or thesaurus.

Stage 3 becomes more interesting when the offshore developer decides to bring its software to the North American marketplace. Obviously, the same kind of problem can exist when dealing with the European or Japanese marketplace or any other market that already has an advanced, computer-literate user population. Even if the new software is bug-free, the developer's cultural assumptions and trappings may cause problems (e.g., with user manuals and GUI interfaces that the American user finds subtly unacceptable). (For another perspective on cultural differences, see "Crossing the Cultural Boundary" on page 107.)

But the real problem involves marketing. The cost to bring even the smallest PC application into the American marketplace can be daunting enough for the American start-up software company, let alone its third-world counterpart in Montevideo or São Paulo. Moreover, access to a million dollars provides no guarantee of success. You can argue that Microsoft and Lotus are juggernauts, not because of their software technology but because of their marketing muscle. Suppose a software organization in India developed a look-alike version of Windows NT that was functionally equivalent but half the price, twice as fast, and only half as big. Even aside from the issue of copyright-infringement lawsuits (which is also an extremely potent marketing weapon), what chance would the Indian company have to market the product successfully?

Perhaps NT is too ambitious. What about a word processor? Many articles in the trade press have complained about rampant bugs and bloated "fatware" characteristics of the latest releases of Microsoft Word and WordPerfect 6.0 (see "Fighting Fatware," April 1993 BYTE). It's easier to imagine an offshore software producer successfully marketing a $100 word processor that provides 80 percent of the functionality of the big-name brands but manages to fit in 256 KB. Even if you were to give it a full megabyte, you'd still be far ahead of the fatware products that require 8 to 10 MB of disk space—and that's just for the DOS versions; Windows software can take 15 to 30 MB or more per package.

The natural reaction is to dismiss such a

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Software in Russia

RONALD B. SCOTT

Back in 1989, when the Perestroika policies of Mikhail Gorbachev began lifting the iron curtain, several people in the information industry seemed to think that Russia had dilapidated facilities, outdated equipment, and technical knowledge and skills that bordered on the Neanderthal. And Russia's well-deserved reputation as a "one-disk nation" limited its appeal as a software market.

That was then; this is now. Russia adopted copyright laws last year, and a new ethical standard has been taking hold. Bootlegging hasn't yet gone the way of the manual typewriter, but nowadays "owning legal software is a status symbol," according to Esther Dyson, an industry watcher who has taken an active interest in eastern Europe and Russia.

Judging by strong sales in the fourth quarter of 1993 and the first two months of 1994, an attitude adjustment is being felt. Hard numbers are elusive and would not be large in dollars, but established companies did up to 70 percent of their annual business during 1993's final quarter, a year in which sales jumped 40 percent overall. Despite inflation, unit sales increased at similar paces. Demand for exhibit space at Moscow's Comtek '94 trade show quadrupled. Novell, which previously sold NetWare through distributors, will open a Russian office in 1994. Compaq plans to sell its machines direct to end users. Oracle is doing well, as are several CAD/CAM developers.

A Two-Way Market

More and more Western organizations are discovering that Russian development teams are extremely cost-efficient (a well-paid Ph.D. engineer earns about $200 a month) and skilled. This may not thrill unemployed U.S. programmers, but it suggests that, despite inflation approaching 1000 percent in Moscow, the Russian software industry has considerable vitality.

In late 1990, Lotus Development opened an office in Moscow, expecting to get more arrows in its back than bills in its wallet. "Our entry strategy was very conservative: Win market share without losing money," says Jane Kitson, president of Lotus Development Russia. Early success prompted step two and its savvy "just in time" strategy. "We had all these rubles that were worth a lot more in Russia than in the U.S., so we reinvested here to strengthen our organization and reduce our cost of goods," says Kitson. "Today, everything but the shrink-wrap and the boxes is produced locally."

Lotus's pioneering actions have paid big dividends. At the present time, Lotus's Russian distributors report that Lotus 1-2-3 (the first Western software package specifically localized for the Russian market) accounts for 90 percent of the DOS spreadsheets in Russia, according to a Lotus spokesperson. Lotus's Organizer, a personal information manager, was the first Windows product for the Russian market; it has virtually no competition, and the same goes for cc:Mail. The spokesperson also reports that "most of the 2 million 386 and 486 computers in Russia are networked," and that Russia is proving a valuable testing ground for Notes, Lotus's group-information communications software.

Ironically, Lotus's network of 11 distributors and 500 dealers—stretching from Kiev in Ukraine to Vladivostok on the Pacific Ocean—has benefited newcomers like Symantec and Microsoft, which finally and grudgingly established a ruble price for their products late last year.

"Getting here first was critical, selling for rubles was essential," says Kitson. "Brand loyalty is stronger here than in the U.S., partly because the previous system taught that competition puts people out of jobs. We worked hard to convince our dealers that competition builds jobs, that it was not disloyal to distribute Microsoft products, too."

As the pioneer, Lotus learned some early cultural lessons. First, instead of betting the farm on the unknown skills of a native, it imported a known expatriate American. "We didn't think we'd find the commercial skill set necessary to

scenario as unrealistic, if not downright impossible—but is it any less plausible than Japan's marketing the Honda Civic and Toyota Corolla against Detroit's 1970s-era gas-guzzlers? In fairness, I should point out that the Japanese had been producing automobiles for their own marketplace for 20 years before they decided to enter the U.S., and they also had a great deal more capital than the typical two-guys-in-a-garage software organizations that are popping up in third-world countries. On the other hand, it was barely over a decade ago that Microsoft and Lotus were, for all practical purposes, two guys in a garage; things change quickly in the software field. In the meantime, you should expect to see foreign-developed software that is shrink-wrapped inside an American software box; the consumer won't know that Russian programmers have developed the software (see the text box "Software in Russia").

Stage 4: Exploiting Home-Grown Expertise

The fourth and final stage in the development of a software industry involves the development of products that take full advantage of the native country's unique areas of applications expertise. I have seen unique applications that originated in Egypt, Brazil, Chile, India, Singapore, and the Philippines. All of them involve indigenous applications expertise that is completely independent of the software technology per se, and all are being packaged as commercially salable products.

Egypt: Multimedia and International Finance. A good example of home-grown expertise is Egypt, which has built some wonderful multimedia applications to catalog, manage, and display its vast treasure of historical artifacts. These applications are likely to be far more sophisti-

make a product and sell it at a profit without making bribes," says Robert P. Schechter, Lotus senior vice president. Second, Lotus gave Kitson the title of president, a distinction it offers no other Lotus country manager. There is little doubt that her title smooths relations with rank-conscious, male-chauvinist Russian apparatchiks and businessmen.

Most barriers weren't difficult to overcome. "All of the professional Russian employees speak decent English. And all the programmers here speak C++, too," says Alexander Lvov, Lotus's director of localization.

There is an ironic side to the software growth story. Although Western products have made significant inroads in the former Soviet Union, few (if any) Russian products have made it out to the West. However, substantial chunks of Russian code can be found in "more products than we know of," according to industry-watcher Dyson. In March, for instance, Probots of Northampton, Massachusetts, released GMS 2.0, an automated modeling system that incorporates advanced mathematical technology developed by the Russian Academy of Sciences. Corel has licensed a spreadsheet from Microinforum in Moscow and embedded it in CorelDraw 4.0.

Many believe that licensing underlying code will make up the bulk of the East-to-West software trade for some time to come. "The technology gap is too huge; most Russian products are obsolete by U.S. standards," says George Tarasenko, a software engineer who emigrated to the U.S. nine years ago and now consults with companies such as Bell Atlantic and Clear Software, a company founded by another Russian émigré, Vadim Yasinovsky.

Over time, though, you can expect Russian engineers to produce more substantial add-in/add-on products. When Microsoft introduced its Russian version of Windows last October, the company sponsored a developers' conference that was packed with engineers who had previously been developing Windows products using the English-language version.

Lvov and Tarasenko see many opportunities for collaboration. "Because of the broad, theoretical education Russian engineers receive, they are good at building the skeleton for a product, while Americans, who receive more specialized training, are good at putting flesh on the skeleton," says Lvov.

"We have much to learn from each other," adds Lvov, who sees real advantages in Western development and compensation practices. "Teamwork was more important than quality in the old Russian system. Everyone was always minding your business," he says. "Now, I have team members to consult with when I need help, but I own my assignment. Before, you weren't penalized for failing—but you weren't rewarded for producing, either." ■

Ronald B. Scott is chairman of the Boston office of Ruder Finn, Inc., a global-marketing communications firm. He writes a monthly column on business in the former Soviet Union for The Boston Business Journal. *He was formerly a marketing executive with Baltic American Software, a joint Russian-U.S. venture. You can reach him on the Internet or BIX at editors@bix.com.*

cated than anything Americans would build in the U.S.

Obviously, the technology of multimedia is being developed largely in Hollywood and Silicon Valley, but the application of multimedia often depends on local circumstances. Every country has museums, and even the U.S. has some historical artifacts that date back a few hundred years—but it's hard to imagine another country with as many millennia of accumulated history as Egypt. And while museums in the U.S. are often ignored by everyone but bored retirees, Egypt's museums and historical artifacts are a major tourist attraction and thus a major source of revenue. In addition, they are a constant source of investigation by scholars wishing to carry out research "at the source." If you were a museum director in Greece, Rome, China, India, or any other country with millennia of history, culture, and historical artifacts to catalog, organize, and present to the public in multimedia form, you would almost certainly find better systems to buy from the museums in Cairo than from those in Cleveland.

Ironically, Egypt has also built some of the world's most sophisticated financial applications for managing its vast array of loans and financial-aid packages from numerous countries, international agencies, and relief organizations. Other third-world countries might find such applications quite useful, and they certainly won't find anything like them in the catalogs of Borland, Apple, or Microsoft.

Hong Kong: The Race Is On. The Royal Hong Kong Jockey Club generates nearly $10 billion in annual revenues from horse racing and other forms of entertainment. The club's MIS organization is certainly on a par with the best in the U.S., and it uses the latest object-oriented methodologies and client/server architectures. But what MIS knows about computer support for offtrack betting is truly unique; there are betting stations sprinkled all over Hong Kong like ATM machines, and the level of sophistication is awesome. Several American municipalities allow offtrack betting, but how many languages and character sets do their systems have to support? How many currencies? The Jockey Club handles all these variables and more. As a result, it is in a prime position to sell its system to other race-happy centers in Australia, Kuala Lumpur, and so on.

Singapore: Shipping Out the Red Tape. Over the past decade, Singapore has become known as a center of high-tech manufacturing; a number of electronics companies and computer firms have regional headquarters there. But for centuries prior to the computer age, Singapore was a deep-water port and trading center for ships plying the waters between Europe and the Orient. As a result, the native population of Singapore knows an enormous amount about shipping and about the paperwork and information processing required to move cargo items on and off ships—customs forms, bills of lading, and dozens of other forms. The faster this paperwork can be processed, the faster a ship can unload its cargo, reload a new cargo, and be on its way to the next port.

Singapore has spent several years creating an extremely sophisticated computerized management system for its deep-water ports. This system, developed with assistance from the National Computing Board as part of its larger scheme to make Singapore an "intelligent island" within the next decade, makes heavy use of expert-system technology. Singapore now markets its port management system to Rotterdam, Hong Kong, New York, and other major ports around the world.

continued

Brazil: Banking on Hyperinflation. Consider the impact of hyperinflation, a problem that the U.S. has not experienced since the revolutionary war. Countries such as Brazil have dealt with the phenomenon for decades, and it has had a pervasive influence not only on their economies as a whole but also on the various computer systems used to operate businesses within those economies. Remember how anxious you were in the early 1980s to get an extra day's interest on your bank account when interest rates were hovering around 20 percent? Remember how annoyed you got at banking inefficiencies, and how nobody could explain what happened to your money in the three days between the rent check's being deducted from your account and showing up in the landlord's bank account?

Well, imagine what it's like to live in a country where the inflation rate is 30 percent per month, where the locals joke that you can tell whether inflation is really bad by watching whether people travel by bus (where you pay at the beginning of the ride) or taxi (where you pay at the end of the ride). In the case of Brazil and a number of other countries, you can also add the fact that banks have nationwide charters, without the crazy-quilt of state-chartered banks that exists in the U.S. The end result is that some of the banking systems developed in Brazil are much more superior to those in the U.S. and are being marketed aggressively in countries whose economies are more like Brazil's than the U.S.'s.

The U.S.: Still Competitive. Meanwhile, the U.S. still has application areas where it can expect to maintain a competitive advantage. For example, the U.S. dominates the world in PC-based operating systems, and it will probably continue to do so for the foreseeable future. Applications and systems involving multimedia technology, agents and wizards, pen-based and wireless/mobile computing, and virtual reality are areas of strength, as is anything involving the information highway. On the other hand, you could have said the same about client/server technology, object orientation, and various other technologies a few years ago—and now those technologies are deployed around much of the world.

A Brave New World

Worldwide competition in the software industry is not a unique phenomenon. Software engineers in the advanced countries can compete with those in the third world, just as American and European automobile companies have learned to compete. But that process cannot even begin until workers and management in the advanced countries learn that serious competition is possible, and that it is real. The software industry has not yet recognized this, but we will certainly see it occur during the next few years. ■

Edward Yourdon is the globe-trotting author of numerous books on structured and object-oriented programming, and editor of the American Programmer *and* Guerrilla Programmer *newsletters. He can be reached on the Internet at yourdon@acm.org or on BIX c/o "editors."*

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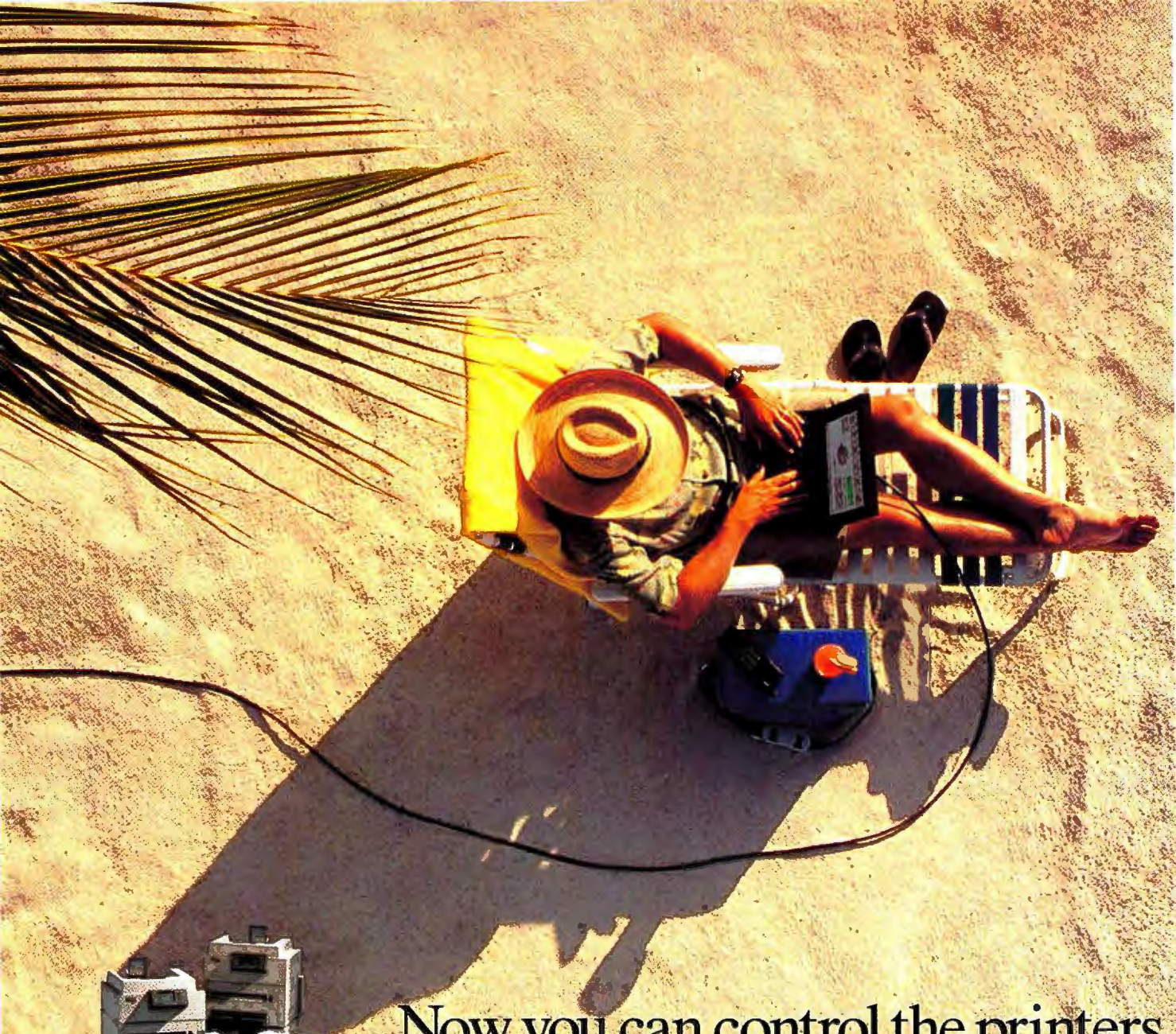
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Performance and data integrity are key.

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The Holy Grail of distributed databases is to supply reliable data anytime, anywhere.

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Traditional EIS systems must adopt to a distributed environment.

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MICHAEL D. MILLIKIN



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Distributed computing deals with higher-level issues than physical media and interconnection. The distributed environments must give users and applications transparent access to data, computation, and other resources across collections of multivendor, heterogeneous systems. The strategic architectures of every major system vendor are now based on some form of distributed computing environment.

The key to realizing the theoretical benefit of such an architecture is transparency. Users can't spend their time thrashing about trying to figure out where something is. Nor should developers have to code into their applications the locations of resources over the network; it is in no one's interest to force applications developers to become communications gurus. Nor should business users have to worry about mounting remote volumes. And from the MIS viewpoint, the network should be manageable. The final picture is one of a "virtual" network: a collection of workgroup, departmental, enterprise, and inter-enterprise LANs that appears to the end user or client application to be a seamless and easily accessed whole.

One technology that will figure prominently in the future of distributed computing is the Open Software Foundation's DCE (Distributed Computing Environment). OSF's DCE is an integrated set of operating-system- and network-independent services that support the development, use, and maintenance of distributed applications. Because of its ability to enable a manageable, transparent, and interoperable network of multivendor, multiplatform systems, DCE could prove to be one of the most important technologies of the decade.

DCE is a technology most users will likely end up licensing from their system vendors. Most of the major players have committed to delivering DCE in future versions of system and network software. For example, IBM, which provides a number of AIX-based DCE products, has broadened its DCE offerings to include PC LANs. In September 1993, IBM shipped a DCE SDK (Software Development Kit) for OS/2 and Windows and, at the same time, made available its first DCE product aimed at PC end users, the DCE Client for OS/2. In February, after months of testing, a Windows cousin appeared. By the end of this year, IBM plans to begin beta testing a new OS/2 LAN Server that will include "snap-on" modules for specific DCE services.

OSF's Distributed Computing Environment standard makes distributed computing usable and invisible

Some large end users, however, went directly to OSF to license the early versions of the software. Those are the sophisticated users—such as Citibank, the Argonne National Laboratory, and the Jet Propulsion Laboratory—that began to develop distributed applications in-house.

For example, Citibank developed a prototype application in which a Sun workstation makes calls to an IBM RS/6000 server, which in turn executes APPC (Advanced Peer-to-Peer Communications) LU6.2 calls that execute on an MVS host. In the past, Citibank developers would have spent months building some of the network application infrastructure (e.g., security, support for APPC, and transactional extensions) for such an application.

In this prototype, however, a client Motif application running on a Sun workstation makes transactional RPCs (remote procedure calls) using a third-party vendor's (Transarc's) transactional extensions to DCE to a server running on an RS/6000. The RPC server there executes APPC LU6.2 calls (using the Transarc APPC run-time library), which execute on an MVS host. Everything participates in the same two-phase commit. Interoperability in this union of MVS and Open Systems is transparent.

continued

Citibank developers get to concentrate on the application rather than the application enablers. That is the promise of DCE in action.

DCE is constructed on a layered architecture, from the most basic providers of services (e.g., operating systems) up to higher-end clients of services (e.g., applications). Security and management are essential to all layers in the model. Currently, DCE consists of seven tools and services that are divided into fundamental distributed services and data-sharing services.

The fundamental distributed services include threads, RPCs, directory service, time service, and security service. Data-Sharing Services build on top of the fundamental services and include DFS (Distributed File System) and diskless support. The OSF has reserved space for possible future services, such as spooling, transaction services, and distributed object-oriented environments.

Threads

Traditionally, applications deal with processes, each of which has a single thread of control. In this model, multiple tasks within applications are divided among multiple communicating processes.

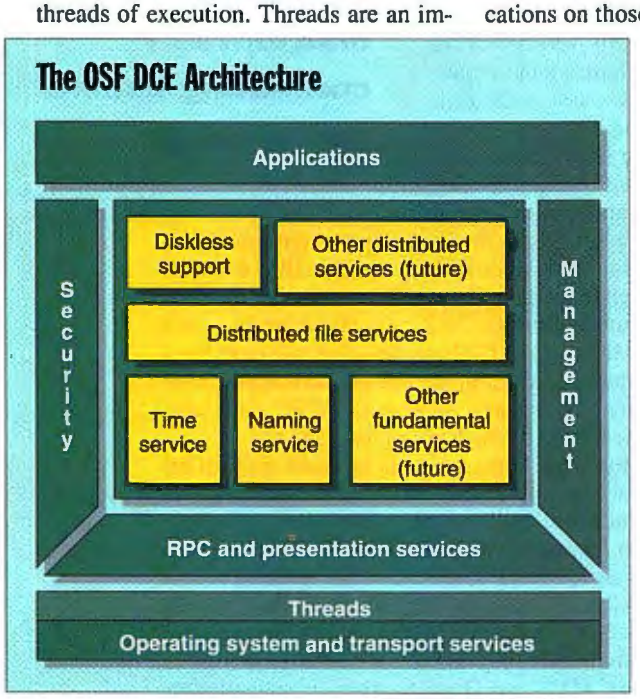
Essentially, threads extend the process model to multiple threads of control that share a single address space and set of resources. A multithreaded program has decomposed a single program into multiple threads of execution. Threads are an important emerging model for expressing parallelism within a process, especially within a distributed environment.

For example, this threading capability becomes particularly important within the context of an RPC. The RPC is synchronous by nature: A client makes a call for a remote function and then waits around until the call is fulfilled. With threads, however, one thread can make the request, but another can begin to process the data from a different request. Threading can therefore greatly improve the performance of a distributed application.

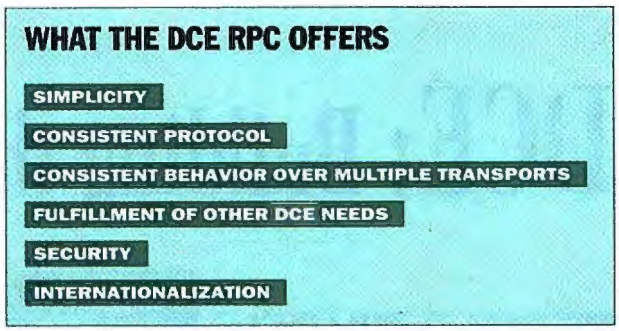
The threads model puts less demand on the skill of a programmer than other parallelism alternatives, such as explicit asynchronous operations or shared memory. Asynchronous interfaces, although they've existed in some environments for some time, can be complex to implement. In the commercial world, the less retraining a new technology causes, the better—retraining programmers can be a major cost constraint. Threads preserve a traditional, synchronous view of the world.

Because of threading's obvious performance benefits, most modern operating systems are multithreaded. Much of the installed base is not, however. To provide threads to support distributed applications on those systems that do not support threading natively, OSF DCE offers a threads package. This is essentially a library of threads routines.

Compared to kernel-based threads, library-based threads have some functional restrictions, but they are really the best choice for broad heterogeneous interoperability at this time. The presence of threads libraries provides a common denominator of functionality across different operating-system platforms that might or might not have native support. The DCE RPC; the security, directory, and time services; and DFS all use the threads service.



The DCE architecture follows a layered model that integrates a set of technologies. The most basic, or supplier, services—such as the operating system—are at the bottom, with the highest level being service consumers, or applications. Security and management apply to all layers.



The RPC

A well-known mechanism for implementing distributed processing, the RPC extends a familiar programming model (the procedure call) across the network. The RPC can handle the nuts and bolts of distribution (e.g., the semantics of the call, binding to the server, or communication failures). In theory, the programmer does not have to become a communications expert to write a distributed network application. Programmers will use an interface specification language to specify the operations. Compiling this then produces code for both client and server. To enable this type of function, the RPC must be simple, transparent, and reliable and must perform well.

The DCE RPC offers simplicity. It adheres to the local procedure model as closely as possible while providing the distributed aspects of applications in a straightforward manner. It foists less of a conceptual change on developers, thereby reducing retraining time. This is especially important for in-house corporate development teams.

Consistent protocol is another DCE RPC hallmark. The RPC protocol is clearly specified and is not subject to user (i.e., developer) modification. This guaranteed core is an important consideration in a heterogeneous environment requiring interoperability. It's a specific design philosophy that the OSF has chosen; proponents of other RPC tools think that flexibility and the ability for developers to customize by adding their own functional extensions are more important.

Regardless of the transport protocol it runs on, the DCE RPC provides identical behavior and keeps the management of connections invisible. The RPC interface



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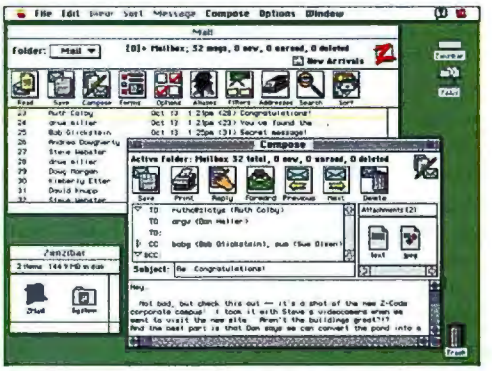
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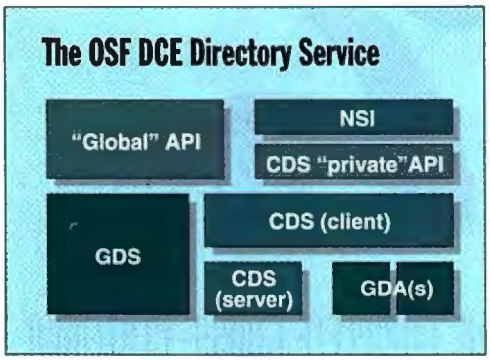
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The CDS is optimized for local access. The bulk of directory service queries will ask about resources within the query originator's cell. The GDA takes queries to names that it cannot find in the local cell and passes them to another cell service or to the GDS, depending on the location of the name. Based on the X.500 standard, GDS functions as a higher level of the directory hierarchy in order to connect multiple cells in multiple organizations.

supports a variety of transports simultaneously, and it allows the introduction of new transports and protocols without affecting the coding of the application.

The DCE RPC fits in well with the other needs of DCE: naming, DFS, security, and time service. The DCE RPC integrates with the authentication system to enable secure communications. It integrates with client and server threads, preserving the synchronous interface while allowing both client and server to exploit concurrency. Its ability to send and receive indeterminate-length streams of typed data supports DFS.

The DCE RPC is integrated with the DCE Security Service to guarantee authenticity, integrity, and privacy of communications. And it supports doublebyte character sets, such as those used in Japanese and other Asian languages.

Distributed Directory Service

Finding things (e.g., users, resources, data, or applications) in a distributed network is the task of the directory service. Name or directory services must map large numbers of system objects (e.g., users, organizations, groups, computers, printers, files, processes, and services) to user-oriented names. The problem is difficult enough in a homogeneous LAN environment, given personnel and equipment moves and changes to names, locations, and so forth. In a heterogeneous global WAN (wide-area network) environment, the directory task becomes considerably more complex, given the need to synchronize different directory databases. Furthermore, as distributed applications appear on the network, the directories have to begin tracking all those objects and their components as well.

A good name service makes use of a distributed computing environment transparent to the user. Users should not have to know the location of a remote printer, file, or application, for example, nor should they have to key in the X.400 mail address for a distant colleague.

OSF specified a two-tier architecture for the name service to address both intracell and worldwide communications. The *cell* is a fundamental organizational unit for systems in OSF's DCE. Cells can map to social, political, or organizational boundaries, and consist of computers that must communicate frequently with one another—workgroups, departments, or divisions of companies, for example. Generally, computers in a cell are geographically close. Cells range in size from two to thousands of computers, although OSF cites tens to hundreds as being the most common range.

Some vendors and users have pushed for the implementation of X.500 as a common directory service at all levels. But the OSF believed that using X.500 at the workgroup (i.e., cell) level would have been cumbersome because of the software and performance requirements—especially when more nimble cell-level directory services already existed in the market.

There are four elements in the DCE directory service:

CDS (Cell Directory Service). A network cell is a group of systems administered as a single entity. The CDS is optimized for local access. The bulk of directory service queries asks about resources within the query originator's cell. Each network cell needs at least one CDS.

GDA (Global Directory Agent). The GDA is a naming gateway that connects the DCE domain to other administrative domains through the X.500 worldwide directory service and DNS (Domain Name Service). The GDA takes queries to names that it cannot find in the local cell and passes them to another cell service or to the Global Directory Service (depending on the location of the name). To look up a name, a client queries the local GDA. The GDA then passes an interdomain name query to the X.500 service. This service returns the response to the GDA, which in turn responds to the client. The OSF GDA can be compatible with any global naming scheme.

GDS (Global Directory Service). Based on the X.500 standard, the GDS functions as a higher level of the directory hierarchy in order to connect multiple cells in multiple organizations.

XDS (X/Open Directory Service). Support for the X/Open API for directory service calls allows developers to write applications independent of the underlying directory service architecture. An XDS-compliant application will work unmodified with both DCE and X.500 directory services.

Distributed Security Service

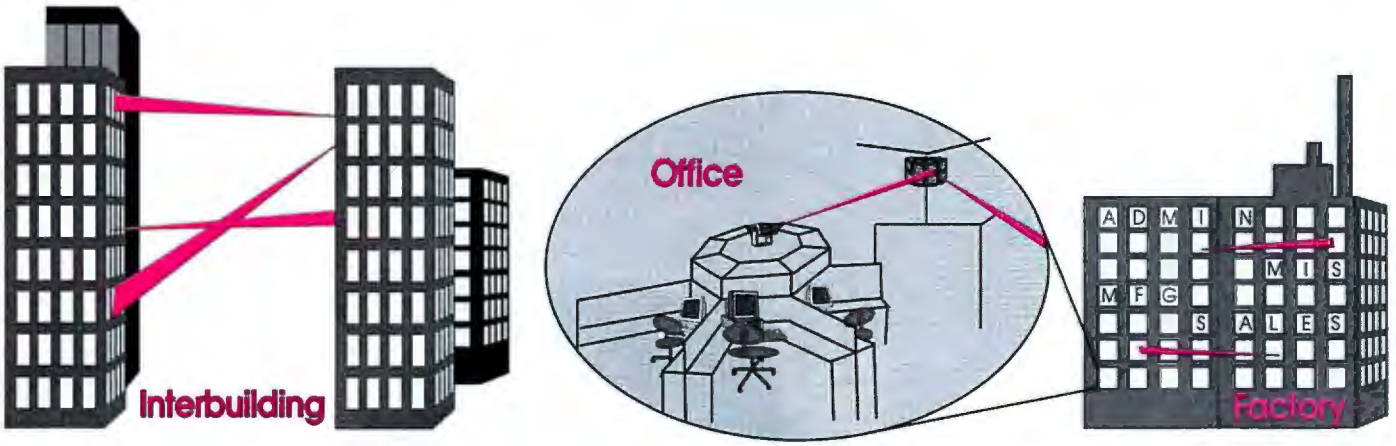
There are two broad general categories of security services: authentication and authorization. Authentication verifies the identity of an entity (i.e., a user or a service). Authorization (or access control) grants privileges to the entity, such as access to a file.

Authorization alone is only a partial solution, however. Authentication services must exist within a distributed network environment where a workstation cannot be trusted to identify itself or its users correctly to shared network services. An authentication service is a mechanism for providing trusted third-party verification of user identities. An authentication service, which basically requires the user to prove his or her identity for each required service, must be secure, reliable, transparent, and scalable.

OSF security is based on the Kerberos authentication system (developed at MIT's Project Athena), augmented by security components (see "Distributed and Secure" on page 165). Kerberos uses private-key encryption to provide three levels of protection. The lowest level requires only that user authenticity be established at the initiation of a connection, assuming that subsequent network messages flow from the authenticated principal. The next level up requires the authentication of each network message. On the level beyond these safe messages are private messages, where each message is encrypted as well as authenticated.

End users should be minimally affected by the network-based service. In other words, you shouldn't have to memorize dozens of passwords or codes. A great deal of the security benefits stem from this network service's managing a user's

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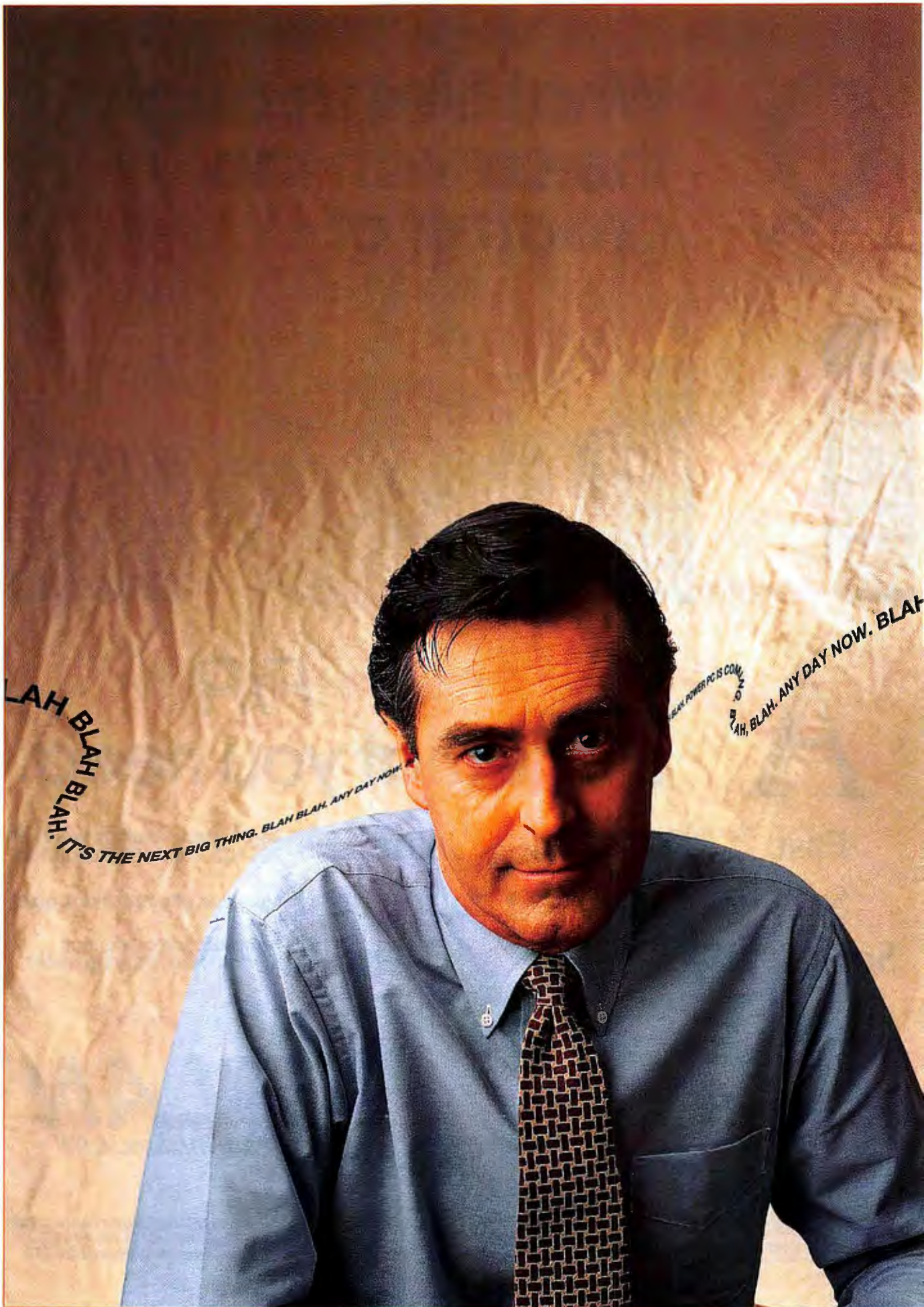
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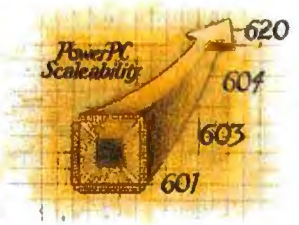
Update

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OSF Reorganizes, Sun Enters the Fold

From the Open Software Foundation's inception in 1988, OSF's relationship with Sun Microsystems was competitive, to be polite. Sun certainly was up to the challenge, with executives claiming that OSF really stood for "Oppose Sun Forever." The resulting contention prolonged the split between the two major Unix camps for years.

All that ended in March 1994 at Uniforum, where OSF unveiled a new business model and process that bring Sun's SunSoft unit into the fold as one of the key members of the new organization. The new OSF (which is retaining the OSF name for the moment) is shifting to a more project-oriented operating model. Technology projects will be funded separately and managed individually, and engineering work will be outsourced. The hope is that this structure will promote more concurrent technology projects, addressing more customer-specific technology issues and requirements in a more timely manner.

The reorganized OSF relies on a new multi-tiered sponsorship structure, consisting of executive sponsors and associate sponsors. Executive sponsorship requires a three-year commitment at a membership fee of $1 million per year. Associate sponsors pay a fee of $200,000 per year. Existing membership levels for nonsponsors remain unchanged.

OSF is also adopting a new technology selection process. In the past, OSF issued an RFT (Request for Technology) for a specific area, evaluated the submissions, and integrated those selected. Under the new organization, project sponsors can take the initiative in proposing a complete development solution in the form of a PST (Pre-Structured Technology). Under the new organization, DCE 1.1 is slated for release in November.

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access—in other words, authorization.

OSF added a registry service and an authorization service as well. OSF is also including authorization checks based on Posix-conformant ACLs (access control lists) and an authentication interface to the RPC.

There is growing de facto support in the industry for public-key encryption systems such as the one provided by the RSA (Rivest-Shamir-Adleman) method. (Microsoft and Apple, for example, are working with RSA technology.) OSF also intends that applications for DCE be portable from Kerberos to public-key authentication schemes such as that provided by RSA.

Distributed File System

The OSF DFS is intended to provide transparent access to any file sitting on any node on the network (security permitting, of course). A major concern in such a distributed file system is making it simple for users. Vendors must address a number of other issues in delivering such a file system.

For example, a distributed file system should have a uniform name space. Files should have the same name, regardless of platform and location. Other features to consider are integrated security, data consistency and availability, reliability and recovery, performance and scalability to very large configurations without performance degradation, and coherent, location-independent management and administration.

The OSF DFS, which is based on AFS (Andrew File System) from Transarc (Pittsburgh, PA), uses four principal components to address these needs: the DCE Logical File System, a protocol exporter (file server), a cache manager (client), and a token manager.

The implementation of DFS provides an excellent example of how the various components of DCE work together. DFS software resides on each node of the network. DFS integrates the node file systems with the DCE directory services, ensuring a uniform naming convention for all files stored in DFS. It uses the DCE security system, with ACLs to control access to individual files. The RPC streaming function allows DFS to move large amounts of data through a WAN in one operation rather than dribbling it across in smaller packets; this capability is very important because of the latencies inherent in a WAN.

To maximize file-access performance, DFS caches frequently access files on a workstation's local drive. When a user accesses data on the file server, a copy of the data is cached locally. When the user is finished working with the data, the file is written back to the server. The result is rapid user access to distributed files.

To prevent problems from arising when multiple users on different computers access and modify the same data, DFS uses a token management scheme to coordinate file modification. This prevents unintentional corruption of distributed files through multiple out-of-sync updates.

DFS allows system administrators to subdivide file-system partitions into *filesets* (logical collections of files). Filesets are not mounted in the local file-system name space but are spliced into the DCE global-directory name space instead. The fileset is referenced by its global directory name, so its name is independent of its location. A fileset moved from one physical file-system partition to another maintains its global name.

Thus, filesets make for easy administration. If a disk partition is getting close to capacity, an administrator can move filesets to another partition or file server.

Distributed Time Service

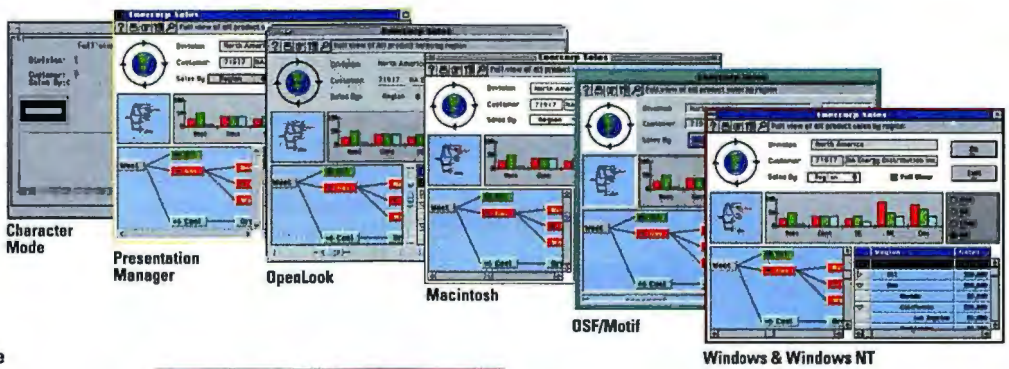
Distributed network systems need a consistent time service. Many distributed services, such as distributed file systems and authentication services, compare dates generated on different computers. For the comparison to be meaningful, DCE must support a consistent time stamp.

In OSF DCE, a time server is a system that provides time to other systems for the purpose of synchronization. Any non–time server system is called a *clerk*. The DTS (Distributed Time Service) uses three types of servers to coordinate network time. A local server synchronizes with other local servers on the same LAN. A global server is available across an extended LAN or a WAN. A *courier* is a designated local

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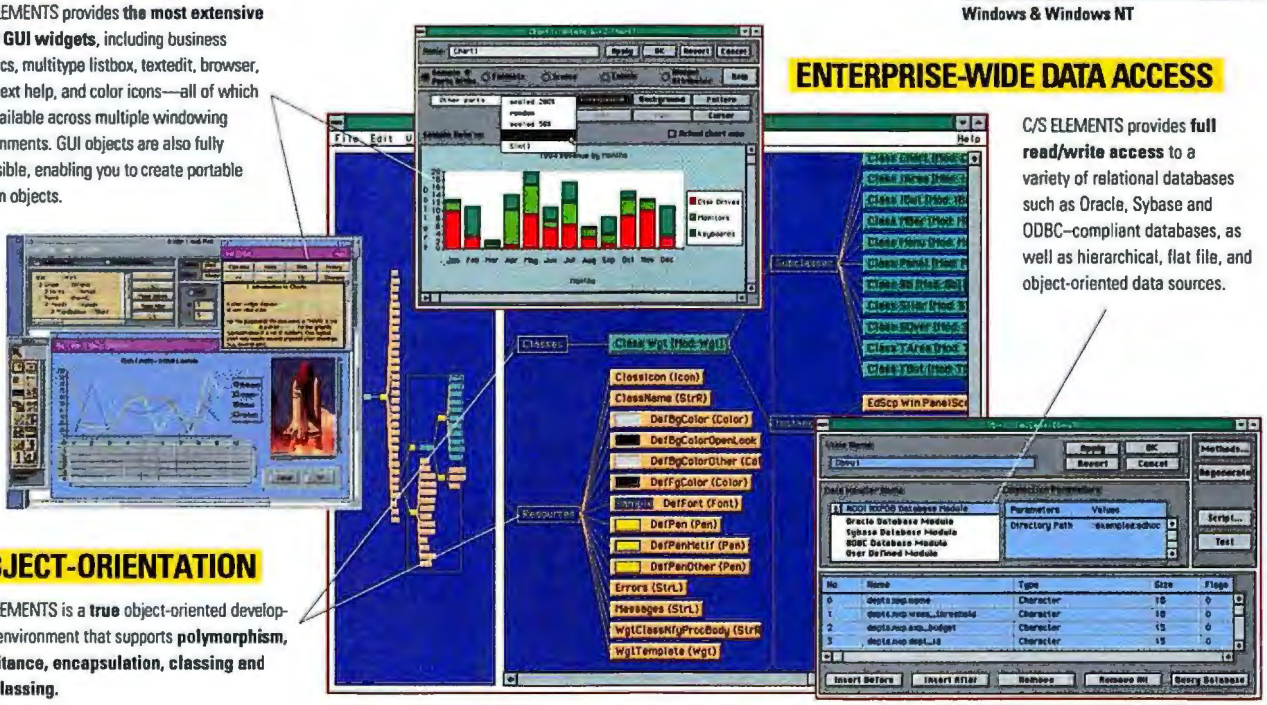


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server that regularly coordinates with global servers. Servers can obtain the official Universal Coordinated Time from standards organizations (e.g., the U.S. Naval Observatory) via short-wave radio, dial-up lines, or satellite.

At periodic intervals, servers synchronize with every other local server on the LAN via the DTS protocol. The OSF DTS synchronization protocol is interoperable with the NTP, the protocol used by the Internet.

Object orientation will prove to be fundamental to the rapid proliferation of network-based applications.

Extending and Using DCE

The premise that DCE lays a foundation for extension is already being tested and proven. Transarc, which provided the basis for DFS to DCE, has released its Encina extensions for transaction processing based on DCE. Major user corporations such as Amoco have committed to DCE, and major system vendors such as IBM, DEC, and Hewlett-Packard are busy implementing and delivering elements of the technology.

The University of Massachusetts at Amherst is using DCE as a foundation for providing an advanced computing environment called Project Pilgrim. The leaders of Project Pilgrim decided that DCE best met their needs for an integrated and comprehensive distributed computing environment. Project Pilgrim is completing its own distributed printing, mail, and event-notification services to layer on top of DCE.

OSF DCE 1.1

Currently, DCE is in release 1.0.3. One of the major goals of DCE 1.1 is improved administrative function. Earlier versions lacked some functions, so it was difficult to configure or administer a DCE cell from a single log-in session. OSF is rectifying this in release 1.1 by providing a new user-extensible control program and a new server that will be able to start servers directly under a variety of circumstances and provide better control over (and information about) what services are running on a host. The new server will also maintain the configuration files that current DCE programs require.

Another major area for enhancement is security. Release 1.1 will see the addition of GSSAPI (Generic Security Service Application Program Interface). The current scope of GSSAPI is establishing security contexts, performing peer-entity authentication, and yielding shared keys. One of its key goals is to provide non-RPC applications operating within a DCE environment with the ability to use the DCE Shared Secret authentication protocol. New audit subsystems in DCE 1.1 will track security-related events.

DCE 1.1 will be further internationalized to handle differing character sets or encodings for text data. The new version will also add support for hierarchical cell naming and extended registry attributes.

Interoperability

Although DCE has been built from many standard technologies and is designed to promote interoperability, it is, in general, an extensive, interrelated environment. That is one of its strengths and also one of its weaknesses. The ability to switch in and out of DCE usage or to work in a mixed DCE/non-DCE environment doesn't appear likely right now. For example, although a DCE Kerberos server supports Kerberos 5, it is not compatible with MIT Kerberos 5. DCE Kerberos runs over the DCE RPC; MIT Kerberos 5 does not. OSF promises full Kerberos compatibility in DCE 1.1, but in the meantime users can solve the problem by taking a dual-stack approach and running both.

There are some exceptions to this tight integration of services within an extensive environment. Some of the DTS, security, and GDS features are stand-alone. In addition, GSSAPI will be in release 1.1. But the essential philosophy behind DCE views tight integration as a feature, not a bug. Accordingly, a burden is placed on the user or implementor in choosing another design path.

This is not an insurmountable barrier. As another example, DCE and Windows NT are said to be compatible, even though NT is not a DCE platform. Compatibility is claimed by virtue of the RPCs' ability to interoperate. After some careful work at the source code level, developers can create DCE servers that communicate with Windows NT clients, NT servers that work with DCE clients, and DCE servers that communicate with DOS clients.

Areas for Extension

For DCE to fulfill its promise of becoming the foundation for widespread heterogeneous distributed computing, it must deliver support in two key general areas: TP (transaction processing) and object orientation.

Support for TP is fundamental to success in the commercial market as a production system. Transaction integrity must be a given for businesses that cannot afford any loss or inconsistency in data. Some of these sites have had gigantic centralized TP systems running for years. The base DCE technology is insufficient to provide the qualities expected in a standard TP system: the so-called ACID properties (atomicity, consistency, isolation, and durability). Transarc provides one solution for this with Encina. IBM offers another with an implementation of its CICS on top of DCE on AIX. IBM actually offers its customers a choice of either Encina or CICS for open TP solutions.

Object orientation will prove fundamental to the rapid proliferation of network-based applications, for some of the same reasons that are propelling the transparency of DCE to developers: It is too hard to write a network-based application without either extensive retraining or a technology that camouflages the intricacies of the network. Object orientation provides this necessary transparency as ease of development. Much of Novell's AppWare family, for example, is based on object-oriented technology. Object orientation will provide the necessary capabilities of reuse and customization required in today's business-oriented computing climate.

OSF is exploring extensions to its RPC interface definition language that will add object-oriented functionality. Once implemented, such features will support the Object Management Group's CORBA (Common Object Request Broker Architecture) on top of the DCE infrastructure. Much of DCE's future success will depend on this sort of extensibility, as well as on the success of the organizational management of this collection of enabling technologies. ■

Michael D. Millikin is vice president of programs for NetWorld+Interop (Mountain View, CA). He is a longtime follower of the OSF technology and process. You can contact him on the Internet at mdm@polaris.interop.com or on BIX c/o "editors."



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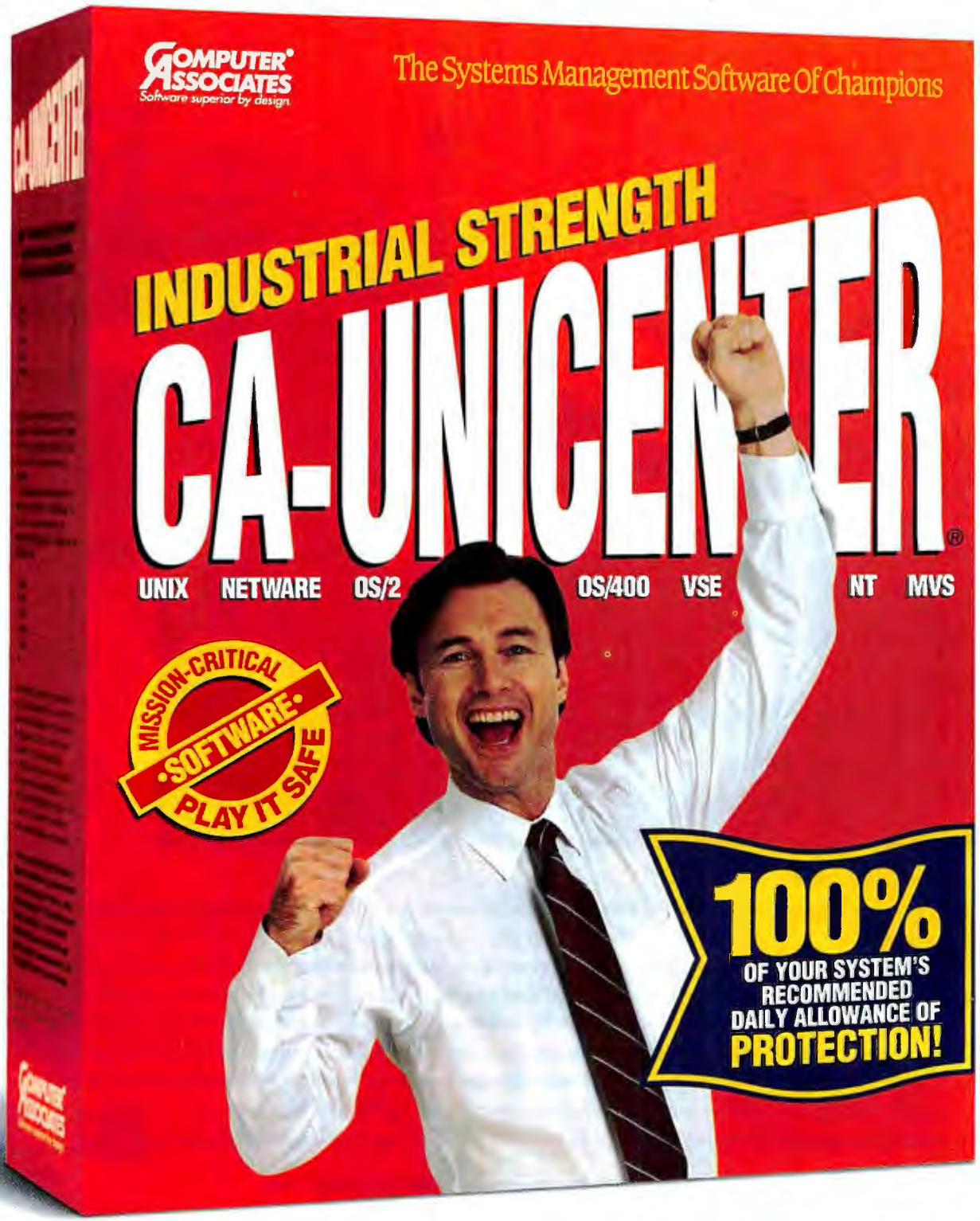
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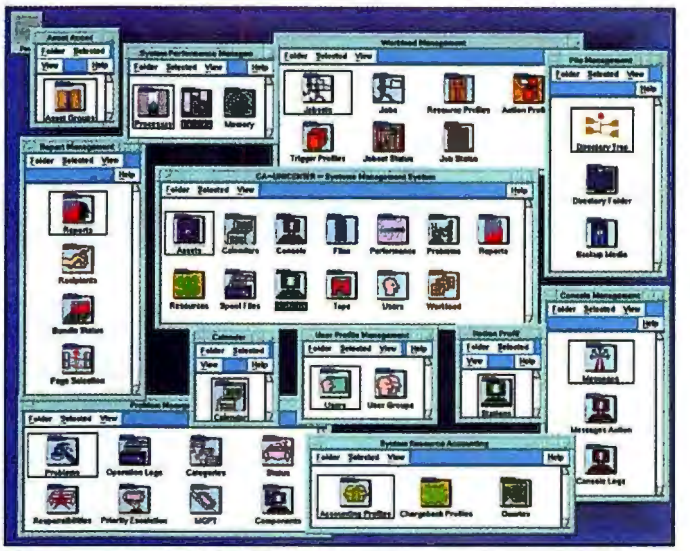
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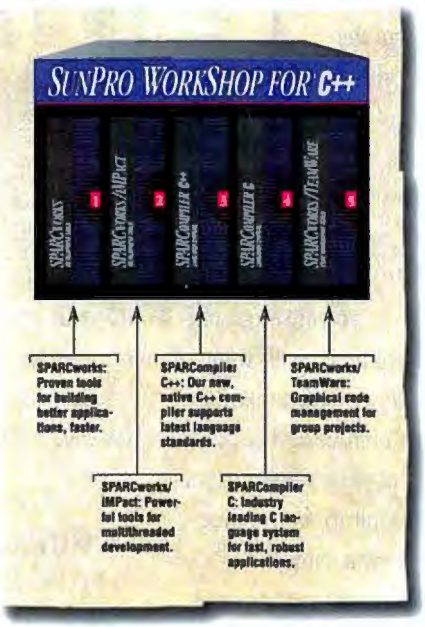
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Distributing Data

JANE RICHTER



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Most business networks fall into one of two categories. The first category includes organizations using a large mainframe database. Users rely solely on IS departments to provide needed information. The second category includes organizations where each user or department has its own collection of data. The organization uses hard copy or replication to share that data. Neither strategy satisfies the need to respond to market changes quickly and cost-effectively in today's competitive business environment.

The solution may be a distributed database. In simplest terms, a *distributed database* is a collection of data distributed, or spread, across many computers. It is one logical, centrally managed database stored in multiple physical locations. By allowing data to be accessed locally and managed globally, a fully functional distributed database can supply reliable information anytime and anywhere. It provides users timely and flexible access to information, it gives them the tools to analyze their data in more meaningful ways, it optimizes the use of computer processor power, and it lets the IS department control the safety and integrity of the data.

The key to a distributed database is transparency. Neither the users nor the programmers need to know where or how the database stores the data. To the user, operations appear to run against one contiguous database. The system alone manages distribution.

What's more, with a distributed approach, users continue using familiar database platforms and products, minimizing the cost of software and hardware purchases and retraining users. A distributed approach also allows users to continue using familiar database applications. A distributed system can often leverage, and in some cases revitalize, existing legacy systems, thus reducing the cost, in time and money, of reengineering database applications and retraining users.

Before you decide to set up a distributed database, take a deep breath. Though simple in concept, distributed databases deal with a number of extremely complex issues. For example, how do you keep data up-to-date when it is physically dispersed? What exists today are a number of evolving, interim solutions.

Distributed databases fill the competitive need to make information available to everyone in an organization

Not for Everyone

Organizations move to distributed databases for one of two reasons. First, they have outgrown the capacity—in terms of either storage or processing power—of their current database server. This situation requires separating a logically centralized database into a distributed database that spans two or more computing processes. Typically, this is two computers sitting side by side (but it may include geographically separated sites) running compatible DBMS products.

Many of the now available commercial database servers support horizontal scaling, which lets database systems include additional servers or processors. The database system transparently distributes the data and the database processing load. Most top-down operations in the business world today work with a comparably sized or scaled-down version of the original centralized database. This approach ensures transparency while maintaining data integrity and applications compatibility.

Second, organizations with physically dispersed sites, each maintaining its own data, are candidates for a distributed database. A possible solution for this type of organization might be to combine all the dispersed databases into one central database. This approach, however, has several disadvantages. First, a central computer would suffer phenomenal processing demands during peak times.

continued

Second, a central computer would become a single point of failure. Finally, communications costs for remote access to a central computer can be prohibitive.

Instead of a centralized database, a bottom-up integration of a distributed database—combining existing databases running on mixed systems into a single, virtual distributed database—alleviates these problems. This approach preserves an organization's investment in database software and applications, as well as allowing the data to be stored where it's used most.

Lehigh University (Bethlehem, PA), for example, has embraced the distributed-database technology. Lehigh converted all three of its mainframe systems to 10 high-end IBM RS/6000 servers and over 140 RS/6000 workstations accessed by thousands of PCs. The network grew from 10 to 30 sites for enterprise data access. Within an 18-month period, Lehigh expanded its system capacity by at least two orders of magnitude and increased the number of

The Other Challenges

Beyond the core technology, you must consider a number of other contributing factors when implementing a distributed database. These challenges encompass issues as diverse as overcoming shortfalls in the supporting technology, interproduct compatibility, troubleshooting multivendor systems, and surviving culture shock.

Challenge #1 is making everything connect to everything else. Communications networks, both LAN and WAN (wide-area network), are the weakest links in the chain (see "Linking LANs," December 1993 BYTE). Links between remote sites are often slow and costly. Problems with network protocols, WAN bandwidth, and network management and differences between LAN and WAN cultures combine to make implementing this piece of the distributed scheme a true ordeal.

There are plenty of challenges to juggling the standard network protocols, such as IPX, TCP/IP, and AppleTalk, not to mention SNA (Systems Network Architecture) and NetBEUI, both of which need proprietary routing. What's more, regardless of whether you lease dedicated communications lines or use a communications server and public phone lines, WAN access costs money, lots of money. That's the bad news.

The good news is that the network industry is probably the fastest-growing segment of the computer industry. The last year has seen significant improvements in the area of communication: faster network cards, improved compression and data-link switching technology, and the vastly faster, more reliable asynchronous communications.

Products like Xylogics' Annex Communications Server continue to break new ground in multiprotocol communication between remote sites. LAN companies are working feverishly with products such as Novell/USL's Tuxedo and Banyan's Vines Enterprise Data Distribution network services to provide data-distribution features as an integral part of their file services. All these advances combine to give hope of acceptable network solutions (in terms of both price and performance) in the near future.

Challenge #2 is overcoming limited standardization between database products. Many vendors (Oracle, Sybase, Ingres, Progress, Informix, Borland, Cincom, and Gupta, to name a few) have ported their software to run on a variety of heterogeneous hardware platforms and operating systems. If, however, you are not dealing with a single-vendor solution, a distributed implementation—specifically, server-to-server compatibility—becomes a serious issue. What's more, many database products follow different database models (e.g., the hierarchical IMS from IBM or Cincom's network model database, Total), posing problems with data access and query translation.

Again, there is hope. Although standards can rarely keep pace with technology, they're beginning to gain ground. On the relational DBMS side, the ANSI/ISO SQL (1986), IBM's SAA/SQL, and the SQL89 and SQL92 standards are a start. The SQL Access Group has recently produced a specification that adds to SQL92 and is at work on parts of the next major SQL standards release, scheduled for 1996. For distributed data, IBM's DRDA (Distributed Relational Database Architecture) provides a set of standard protocols for access to remote data spanning a variety of platforms previously inaccessible (i.e., DB2 for MVS, AIX/6000, and OS/2; SQL/DS for VM and VSE/ESA; and OS/400). Compliance with these standards ensures increasingly more sophisticated database interoperability and portability.

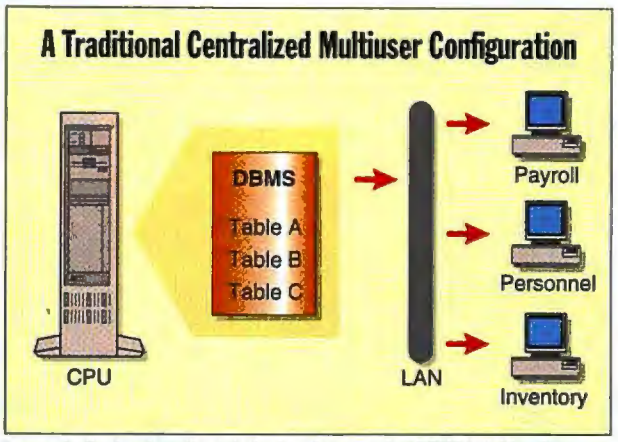
Middleware products, such as drivers based on Microsoft's ODBC (Open Database Connectivity) standard and Borland's IDAPI engine, insert a set of compatible drivers between the database servers, thus ensuring reliable communication among DBMS programs. Gupta's SQLBase Server and Cincom's Supra Server offer faster, proprietary middleware drivers for many popular DBMS programs. Many of the second-generation distributed-database products, such as EDA/SQL, also use proprietary drivers as part of their transaction management scheme. Middleware is slow and somewhat limited in scope, but it is still a relatively new technology.

Gateway products, including products and services from Micro Decisionware and Teradata, tend to be faster. Gateways provide often expensive translation links to a variety of popular DBMS products and platforms, including DB2 and AS/400. (Micro Decisionware's Database Gateway for MVS costs a minimum of $7995 and the Access Server for MVS-CICS runs $65,000 to $155,000; an EDA/SQL installation can run upwards of $100,000.)

For now, limited standardization requires requesting heterogeneous servers

publicly accessible sites by more than 40 percent. What's more, this was accomplished with a comparably sized budget and staff, according to Bruce Fritchman, assistant vice president for computing and communications services at Lehigh.

The university runs its traditional admissions and development databases on Oracle 6. The network uses a distributed-database service, the Andrew File System from Transarc (see "Distributed and Secure" on page 165), to handle all user access and authentication across its entire network system. Also, Lehigh has developed an internal distributed information-services database to provide E-mail, BBSes, conferencing, library services, on-line forms processing, and pass-through access to national networks to all its users.



In a centralized system, the data is stored on a central DBMS in tables. Users throughout an organization access the tables concurrently through a terminal or networked PC.

"We made some guesses about where the technology was going," says Fritchman. "We took some chances. You don't make progress if you don't take some risks."

The first-generation distributed-database products (e.g., Oracle 6 and Sybase/Microsoft's SQL Server 5.x) generally offer an all-or-nothing approach to going to the distributed model. A first-generation distributed solution requires conversion of *all* your databases, regardless of platform, to run under the same DBMS program. Though most of the first-generation vendors provide support for a variety of platforms, many organizations find the cost of converting to a homogeneous, single-vendor solution prohibitive. Nonetheless, these offerings represent a critical first step toward achieving true distributed-database systems.

Second-generation products solve many of the short-term issues with heterogeneous distributed-database implementations. Foremost among these issues are cross-server and cross-platform data access and security, and integration of distributed and nondistributed systems. New and upcoming releases from the DBMS vendors address many of these issues. Additionally, data-warehousing tools, such as Dynamic Information Systems' Omnidex; middleware, including a horde of drivers, routers, and gateways from companies ranging from Borland to IBM; integrated data-access tools, such as the Personal Series from Uniface and Information Builders' EDA/SQL; and integrated programming tools, such as Cognos's PowerHouse, Open Environment's OEC Toolkits, and Inference's ART*Enterprise all provide unique solutions for data access, security, and integration.

These second-generation products provide more flexibility in terms of which systems and DBMS products can be part of the network. However, many of the technical issues surrounding true transparent distributed databases remain unsolved in today's commercial products.

Understanding the Technology

Centralized systems store data in tables in a central DBMS. Users access the tables concurrently through either dumb terminals or their PCs via a LAN. Typically, these servers reside on more powerful machines (e.g., a Unix-based minicomputer or a mainframe). Even if run on a PC LAN, however, this configuration still solves many of the problems with maintaining data integrity, eliminating redundant data, and processing changes, deletions, and updates concurrently. Centralized databases also simplify routine services (e.g., security, backup, and maintenance).

Nevertheless, when dealing with remote access, centralized systems are at the mercy of the communications lines. Also, they generally require a dedicated staff—at least a database administrator, and often an entire IS department—to construct, optimize, and maintain the database.

A decentralized configuration has both data and applications located in independent sites. Key to the decentralized configuration is the concept that the data is not a shared resource. Each site maintains its data locally and updates the central database at regular intervals. These sites can share data, but they typically lack the facilities (e.g., mechanisms and procedures for communication and data-integrity controls) to do so. Exchange of data among these sites is often difficult and expensive.

In situations where the data needs to be a shared resource, a distributed multiuser

to settle for a generic data set. Short of converting to a single-vendor solution, the alternatives are limited. You get by with the functionality and speed of a middleware solution, accept the expense of a gateway, or violate the distribution transparency rule, bypass the TMs (transaction managers), and write applications specifically for the target servers. Like the network technology, however, this is a rapidly growing field.

Challenge #3 is surviving culture shock. Traditionally, mainframe, minicomputer, and PC users do not mix. The same can be said for LAN and WAN users. They don't use resources in the same manner, they don't approach problems in the same way, and they don't even speak the same language. With the proliferation of distributed databases, all these users need to cooperate and communicate. Management needs to take steps to ensure that all the human factions of an implementation will work together.

Challenge #4—and perhaps the biggest headache—is troubleshooting a distributed database. At the very minimum, a distributed database deals with two computing processes, two operating systems, two DBMS products, a communications network, and a database, complete with applications. Problems can occur anywhere, or in a combination of places. Needless to say, the potential problems progress at an exponential rate as the number of sites increases.

Furthermore, many of these problems involve more than one hardware or software vendor. Luckily, vendors seem to realize the importance of working with their customers, and many provide services specifically designed to help solve these types of problems.



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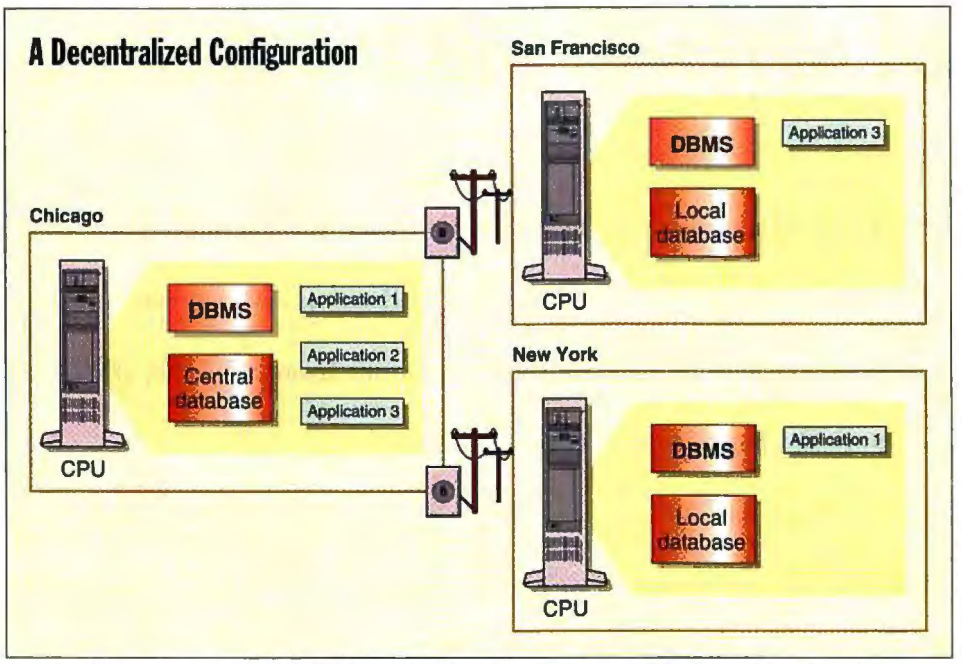
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A decentralized approach assumes that data is not a shared resource. Each site maintains its own data and updates the central database only at regular intervals.

database may be the solution. As with the decentralized model, each site has an independent CPU and DBMS, as well as its own data and applications. Also, each site has an added component to enable shared data: a TM (transaction manager). The TM analyzes a request for data from the user and directs the request to the appropriate server. That server acts upon the request as if issuing it locally (thus distributing the processing) and returns the answer set to the requesting TM. The requesting TM analyzes, collates, and stores the replies from each server, and (eventually) the user sees the result.

Drawing the Battle Lines

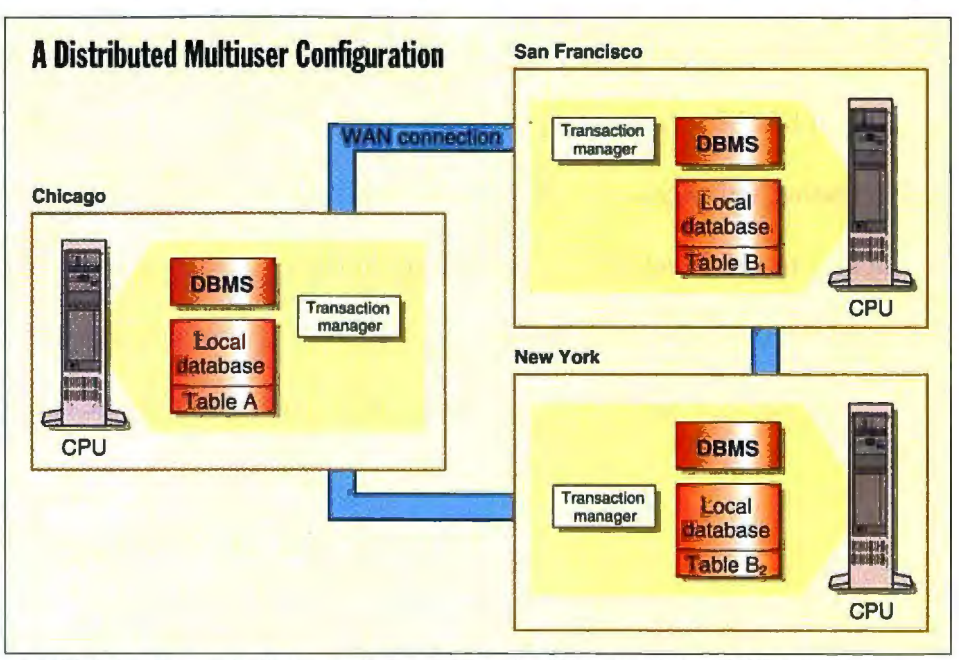
The success of the TM model rests on two critical factors. The first is that the TM must accurately know where the required data tables are. Second, the TM must properly handle change operations across servers; vis-à-vis, it must "synchronize" the data. Although these factors seem straightforward, they represent the real battle lines in distributed-database competition.

There are three general approaches to solving the data-location problem. In the first approach, each TM maintains its own system catalog and has a replicated global system catalog with key information from all sites. Each system is aware of every other system through the global system catalog. The advantage to this approach: When the catalog changes, the communications networks need to transmit only the changes. The obvious problem, however, is integrity. This type of system must include a master mechanism for tracking local catalog changes and making timely updates to all the replicated information.

In the second approach, each TM maintains its own system catalog and automatically examines the system catalogs of the other TMs before beginning a search. Each system is aware of the other systems only through the communications network. This approach potentially shares many of the communications woes of the centralized configuration. It also raises the issue of system failure: If a system is offline, the database is ignorant of that data.

In the third approach, one TM maintains a global catalog, and all other TMs examine this catalog before beginning an operation. This global catalog creates the illusion of a central database: Each site has complete knowledge of every other site. To some degree, a centrally stored global catalog shares all the problems of the centralized-database model: excessive processing demands during peak times, vulnerability to system failure, and the expense (in both time and money) of remote access to the global catalog. On the other hand, when everything's working, it's the fastest and most reliable way to locate and access data.

Cincom's Supra Server circumvents the problem of data location by using its DRDM (Distributed Relational Data Manager) technology as a TM. The DRDM includes a distributed *metadata* catalog as well as rules for handling changes across the system. The metadata catalog includes



The distributed multiuser model, like the decentralized model, employs independent CPUs and DBMSes at each site. However, the distributed model assumes that data will be shared among the sites. A TM at each site monitors and analyzes requests for data.

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the key information catalog plus information about the physical site of the data. All subsequent database operations (distributed or not) run against the DRDM, thus ensuring accurate data.

Alternatively, Sybase uses its System 10 OmniSQL Gateway interface to provide location transparency. The OmniSQL Gateway centrally stores a single global catalog that maps data and other database entities to their distributed locations. All distributed transactions run through the gateway. Along the same lines, data-warehouse solutions such as Omnidex maintain and use a central repository of indexed data structures and keywords for rapid data location and extraction. The drawback to warehousing is that it is read-only and is typically updated only periodically. Finally, Oracle stores a central catalog of directories (i.e., data locations) but local catalogs of data (i.e., data dictionaries).

The second factor in transaction management, that of properly synchronizing data across servers, is equally complex. In traditional two-phase commit, one site serves as a controller. The controller site confirms that all sites are ready to post changes, commits the change at all sites, and waits for all sites to confirm a successful commit. If any site fails to confirm, the controller site rolls back all sites to keep them synchronized with the failed site.

In a distributed database, this can be a nightmare. To compensate, vendors have moved beyond the traditional two-phase commit. For example, Supra Server uses a form of retroactive polling to compensate for a failed commit. Once a transaction begins (i.e., all sites confirm availability for a transaction), all involved sites become *transaction partners*. The coordinating site posts a list of partners to each of the participating sites. If a site becomes unavailable for the second phase, Supra Server may, at the discretion of the remaining partners roll back the entire transaction, or it may ignore the inactive site and post the changes to the active sites. In the latter case, when the off-line site becomes available, the DRDM alerts it to changes, and it falls to the newly restored site to poll the other partners for the updated information.

Alternatively, Sybase 10 and Oracle 7 (as well as the upcoming Gupta SQLBase Server 6.0) "batch" the changes for the inactive site and post them when the inactive site comes back on-line, using a technique called *store and forward*. For example, Sybase SQL Server, using data replication implemented through the Sybase 10 Replication Server, selects a primary site as the data keeper. All changes to the data run against the primary site. When the primary data changes, the Replication Server automatically and transparently updates the replicated data across the distributed system. If a particular site is unavailable, the Replication Server queues the transactions and posts them as soon as possible.

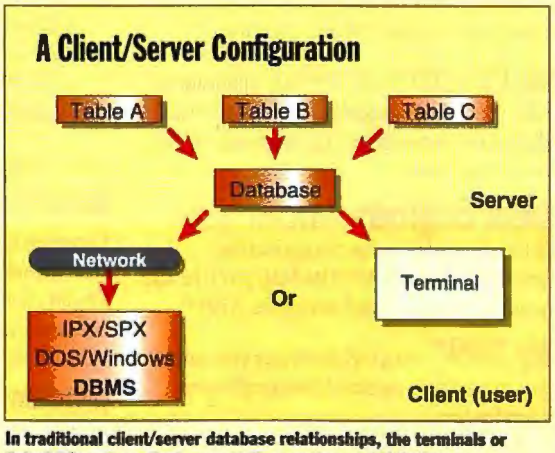
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Defining the Client/Server Distributed Model

There is a lot of confusion about how the client/server model fits into the distributed-database scheme. In any centralized database, the relationship between any of the users (whether they employ dumb terminals or PCs connected via a LAN) and the central database can be characterized as client/server. The client terminals or linked PCs request services and data from the centralized server. What's more, these relationships often exist in distributed systems; a system might act as a server in one transaction and as a client in another. In a distributed client/server relationship, both the client and the server (hardware and software alike) share data-repository and database-processing duties.

A new generation of client/server developers now sees the potential to extend the traditional distributed client/server model to include the networked PC clients. In other words, they want to turn the traditional networked PC–client/server relationship into a full-blown distributed client/server relationship.

The advantages are obvious. Distributed PC client/server systems retain the security and the power of a back-end DBMS while gaining the easy-to-use PC database products as front-end tools. Users have the option of manipulating the data locally via a DBMS engine.



In traditional client/server database relationships, the terminals or linked PCs act as clients, requesting services and data from a centralized computer, or server. The database resides entirely on the server. In distributed client/server relationships, however, both the client and the server maintain a portion of the database (data and processing) and alternate between acting as client and as server.

The real issue with a PC-based distributed database, as with any other distributed system, lies with the transaction management. The PC versions of the back-end products (i.e., Oracle, Sybase's SQL Server, and Gupta's SQLBase Server) can often be difficult to use and also suffer from poor performance. The balance of the PC offerings (e.g., Microsoft FoxBase or Borland's Paradox) simply do not natively include the necessary transaction management facilities to be part of a distributed-database system.

While many of the PC-based database and database development products include tools to ensure data integrity and security, most MIS departments balk at the idea of placing mission-critical data into the hands of users. As the industry solves the problems of data location and transactional management, distributed PC client/server computing will also come into its own.



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DISTRIBUTED TRANSACTION MANAGEMENT

DBMS	DATA LOCATION	METHOD
Cincom Supra Server	Distributed master catalog (through DRDM)	Transparent read/write (through DRDM); transaction partnering; transparent intervendor read/write via DRDM-supported drivers
Sybase SQL Server 10 (through OmniSQL Gateway)	Central catalog	Transparent read/write and store-and-forward (both through Replication Server); intervendor read/write through gateways or ODBC
Gupta SQLBase Server 5.1*	Not applicable	Not applicable
Oracle 7	Central directory catalog; local data catalogs	Transparent read/write; store-and-forward; intervendor read/write through third-party, X/Open XA-compliant distributed transaction processor

* Gupta plans to implement distributed transaction management in SQLBase Server 6.0, due this summer.

So far, the industry has found no definitive approach to addressing data location and transaction management. Perhaps this is because no two organizations are quite the same. The "definitive approach" depends on how tightly the organization's sites must integrate, how accurate the intersite data needs to be, and how much activity the communications network (and the budget) will bear. Until there is a consensus on these factors in the marketplace, all these technologies will likely continue to grow and prosper in parallel.

Distributed databases, especially those involving PC networks, still have a "pioneer" feel. The first generation of product offerings has come a long way toward making distributed databases a reality. Second-generation products provide more flexibility in terms of the degree to which a business can use the distributed model and in terms of which systems can be part of the distributed network.

Although many of the technical issues surrounding true transparent distributed databases remain unsolved, the business demand for client/server and enterprise-wide computing will almost certainly continue to drive distributed-database technology to more refined and sophisticated heights. As Lehigh's Fritchman says, you don't make progress if you don't take some risks. ■

Jane Richter is the owner and operator of Database Developers Exchange, a database courseware company in Ben Lomond, California. You can reach her on the Internet or BIX at editors@bix.com.

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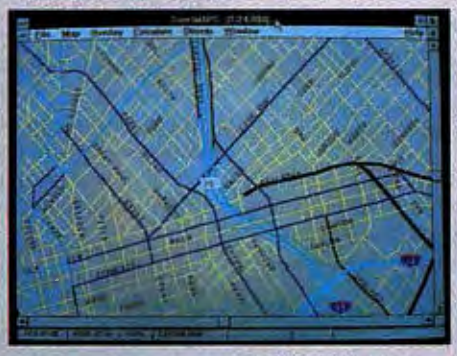
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Managing Storage

ANDY REINHARDT



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Storage management can mean anything from data backup and monitoring the health and performance of disk drives to the use of new distributed file systems. A better definition looks past the means to the ends of storage management: to provide users with optimal system performance and minimum downtime while protecting electronic assets.

As an organization makes data more available, it also must more aggressively protect it. Implementing rigorous media monitoring, backup, and file-grooming procedures, for instance, may seem like a burden to users, but it's the only way to ensure that the right data will be there when they need it. In fact, as organizations shift from hosts to distributed models—or as their LANs evolve upward to assume more enterprising functions—they are starting to demand storage management tools as robust and sophisticated as those tools created for mainframes.

The move to distributed computing is thus being matched by a concurrent shift toward centralized storage management. "The notion of distributed computing is a distinct issue from distributed storage," says Bill North, the director of advanced products for Storage Dimensions (Milpitas, CA). "Even in the most distributed environments, you're trying to put your data in a centralized place, so it can be managed."

Of course, the meaning of *centralized* can vary; hard drives and other devices may themselves be physically dispersed in a distributed environment, because storage management is implemented largely at a logical level. Whether data is consolidated on a single giant server or scattered across an array of smaller systems, centralization gives network managers a unified view of storage resources and lets them assert control over otherwise haphazard processes such as drive-performance monitoring and backup.

Asset protection is one of the factors driving storage management into LANs. "Sometimes data at the desktop is as valuable—as strategic—as the data in the server or the mainframe," says Jay Carlson, president of Vinca (Orem, UT), a start-up company pioneering new storage architectures. "The issue of recentralization of data will dominate distributed computing over the next decade." Another major driving force is cost-containment. Mike Peterson, president of research-firm Peripheral Strategies (Santa Barbara, CA), says: "The big myth is that storage in PC LANs is free; it may cost only $1 per megabyte, but the labor cost of managing that is pushing $8 per megabyte per year."

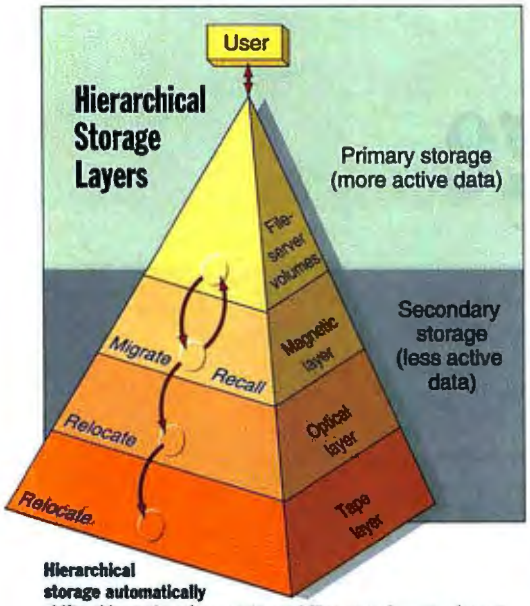
The challenge of managing decentralized storage is to make it accessible with optimal performance at an affordable price

Fortunately, implementing storage management need not turn into another tug-of-war between MIS departments and freewheeling users. If properly executed, storage management is not only transparent to users but ultimately helps them retrieve data more easily, spares them the burden of looking after their own disks and data, and boosts system performance. Unfortunately, many of the storage management products available today for LANs address only part of the problem, and most don't work together in a unified framework.

Making the Best Use

Assuming that you already have adequate security, reliability, and physical management, the key challenge in storage management is to make the best use of your available media with the minimum need for human intervention. This is the fertile area in which HSM (Hierarchical Storage Management) resides.

continued



Hierarchical storage automatically shifts older or less frequently used files away from the fastest and most expensive storage media to other media, such as optical or tape, that are slower and less expensive. The physical location of the storage is unimportant: HSM can centrally manage media distributed throughout a network.

Some people see HSM as an extension of backup and archiving, but in fact, its technology is much closer to that of a cache. As in a cache, the point of HSM is to keep the most current, the most frequently accessed, and the most urgent data as close as possible to the place it is being used, while intelligently discarding that which is no longer needed. The limited space in the cache is at a premium, and not everything needs to be there.

The algorithm that drives backup is based on whether a given file has already been archived and whether it has changed since the last archive. Backups don't delete the source files after copying them to the secondary media. And backup software, which operates in a batch mode, is optimized for backup speed so that the process takes the least possible time and interferes as little as possible with normal system operations. Restores can be done more leisurely because they're assumed to be infrequent.

HSM is nearly the opposite. Migrating files, which involves making a copy and deleting the original, takes place in continuous sweeps, as thresholds are crossed or trigger events occur (i.e., files pass the one-year age mark), and can thus proceed during idle processor cycles with no particular urgency. But demigration has to be instantaneous: If you require a file that is no longer on-line, the load operation ideally ought to take only marginally longer than it would have if the file was on disk.

The algorithms used in HSM to choose which files to migrate weigh several factors. The primary criterion is usually disk capacity; the administrator sets high and low thresholds, or *watermarks*, and the HSM engine keeps disk capacity between these levels. When the high threshold is crossed, the engine typically looks for the oldest eligible files to move. But to minimize the potential need for demigration, sophisticated algorithms will choose one large but younger file in preference to lots of small but older files.

When a file is migrated off the primary storage medium, HSM systems often leave behind a placeholder, or *token*, that consists of a pointer to the file's new location or an index entry in a server database that tracks the actual location of the file. The latter approach is safer, especially if the database is redundant. Unless the HSM is tightly integrated with the underlying operating system, it's more difficult for it to trap disk calls and redirect them to a separate file manager.

The trickiest problem in HSM is how to handle the situation when you request a file that needs to be demigrated but is too large to fit onto the space available on the hard drive. According to Robert Wight, president of Avail Systems (Boulder, CO), his HSM system accommodates this problem by premigrating the files that are next in line for migration. *Premigrating* means that the files are left on the drive and also copied to the next level down; therefore, if you quickly need the space the files occupy, you can delete the files from the hard drive and restore them later.

Similarly, some HSM systems fail to quickly remigrate a file that has been demigrated because they see it as having been recently accessed, which fools the algorithm into thinking the file is current. Avail's software treats remigrated files instead as if they were premigrated, which means that they go back to a lower level in the hierarchy as soon as the next sweep occurs.

HSM is one of the hottest topics in storage management right now because it solves several problems at once. Migrating old or infrequently used files off onto inexpensive media such as removable optical disks or tape not only frees up space on the primary device for more current or important files but also reduces the average cost of your storage. "By implementing HSM, you put a stop to your on-line growth and grow into near-line media instead," says Mike Kidd, vice president of marketing for Palindrome (Naperville, IL). HSM is not a substitute for backup but rather complimentary to it.

Another benefit of HSM, says Avail's Wight, is that it increases aggregate network performance by optimizing access time for the data you're most likely to need. "With HSM, the focus of network drives becomes speed, not storage," he says. "Your concern becomes performance, not capacity." In a complex HSM pyramid, you might have ultrafast cached hard drives that are layered above 10-GB single-spindle Seagate drives, which are layered on top of an optical jukebox for near-line storage, which is layered above a tape library.

HSM comes from the mainframe world, where it was used to minimize storage costs that were 10 times what they are in distributed networks, says Robert Hamilton, product manager for tape and optical-storage products for Storage Dimensions. In fact, the relatively low cost of storage in distributed systems has made implementing HSM less urgent and consequently has held back its market penetration, he argues. "Customers aren't asking for it because they're so delighted not to be paying $10 per megabyte."

Indeed, the low cost of distributed storage has encouraged users to buy more drives rather than to use existing drives more efficiently, and this has ultimately led them to seek HSM for a different reason: as an easy way to implement disk space management. "It's a way of prioritizing your data," says Igor Stenmark, program director for the software management strategies service of the Gartner Group (Stamford, CT). Only 25 percent of the benefit of using HSM accrues from lowered media costs, says Palindrome's Kidd; 75 percent of the benefit comes from reduced management overhead, because you no longer have to worry about space planning and file grooming.

The small number of vendors who now sell LAN-based HSM—primarily Conner Storage Solutions (Lake Mary, FL), which licensed its software from Avail, and Palindrome, whose HSM module layers on top of Network Archivist—argue over the fine points of their implementations, but they are functionally very similar. The basic requirements for an HSM are that

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it support a hierarchy of storage devices, ranging from the fastest and most expensive hard drives to low cost-per-megabyte tape autoloaders. Several analysts consider solutions that support only a fixed number of levels to be inadequate.

Using an algorithm that takes into consideration disk capacity thresholds, file aging, and sometimes file type (i.e., you can set the rules so that certain types of files such as executables or DLLs are never migrated), a rules engine does the following: It watches the drives to make sure they stay within their thresholds; it moves files from one medium to another as necessary; and it tracks file locations in a database. When you try to load a file, the engine intercepts the request and looks it up in the database; if the file needs to be remigrated from tape or an optical drive, it's copied back to the hard disk and given to you.

A function that is intimately related to file access might seem like an obvious candidate for inclusion in the operating system, and in fact, both Novell and Microsoft are moving to support HSM. However, as with other third-party functions that get added to the operating system, their support will consist of a simple "out-of-the-box" implementation coupled with an API that allows richer external products to plug in. "We believe that operating-system companies already have a lot on their plates, and they won't fill this niche completely," says Hinda Chalew, director of strategic marketing for Cheyenne Software of Roslyn Heights, New York.

What to Look for in HSM

- support for unlimited layers of media hierarchy
- media independence
- a rules engine that supports capacity and time thresholds, exceptions by file type, and forced migration
- migration optimized to create minimal need for demigration
- the ability to remigrate files quickly without manual intervention
- support for data typing when it exists in operating systems
- fast demigration

Unified View

One problem faced by network administrators is the so-called "swivel chair effect," caused by a proliferation of network management consoles on their desktops. Eliminating multiple displays requires integrating management applications into a common framework. Because of the widespread adoption of SNMP (Simple Network Management Protocol), most internetworking devices such as hubs and routers can report their status to, and be managed from, a single console. But storage management systems have remained largely isolated.

Legato Systems (Palo Alto, CA) is working on an SNMP agent for its storage management products that will let the products be integrated into Novell's NMS (NetWare Management System) and into enterprise-wide IBM NetView environments. A similar capability is expected from Cheyenne this year. When these capabilities arrive, network managers will be able to monitor and configure storage resources with the same user interface and display they use to analyze network performance, manage network hardware, and even set up user accounts and permissions.

Intel (Hillsboro, OR) is also moving to integrate support for its StorageExpress, a dedicated NetWare-based backup server, into LANDesk Manager, its Windows-based network management system. StorageExpress now snaps into Novell NMS, and LANDesk communicates via SNMP to high-level frameworks such as NetView. The benefit of linking these capabilities together, says Ed Guzman, strategic marketing manager for networking storage products at Intel, is that storage events can trigger network management events, or vice versa. For instance, the failure of a local drive could prompt the hub to close access to that node and kick off a backup sequence to another device.

Future Files

If storage management in distributed environments raises problems and requires solutions that didn't exist in centralized systems, this is only the tip of the iceberg. Just around the corner are fundamental changes in the conception of file systems and documents that may require a rethinking of storage management.

The technological shifts underlying this trend are the emergence of "locationless" network services and the rise of objects and object file systems. In today's computing model, a file stands on its own and resides in a specific place. Advanced operating systems like Windows NT support rich data typing, yet files are still backed up and migrated using conventional attributes such as date/time stamp or archive bit.

But when software moves to a document-centric model, as Microsoft promises to do with the Cairo operating system, the meaning of a file changes. "Smart documents will require us to handle backup very differently," says Alan Adamson, director of product management for Symantec/Peter Norton Group (Santa Monica, CA). "A document will no longer be a single file but rather a book of pointers to text objects, data objects, images, fonts, and so on." Backing up with conventional approaches could cause the linked objects to be separated onto different media, making restoring a nightmare and endangering the integrity of the links.

Obviously, backup and HSM for compound documents will have to respect links, grouping related files together. Microsoft's

TRADE-OFF BETWEEN PERFORMANCE AND COST PER MEGABYTE

In the classic storage pyramid, access speed is closely correlated to cost. The rarest and most expensive storage types, such as cache memory and flash RAM, cost orders of magnitude more than hard drives or removable media such as tapes and optical disks on a dollars-per-megabyte basis but also deliver data hundreds of times faster. Storage management optimizes the use of all media types.

Medium	Cost/megabyte (range)	Access time
Solid-state	$60–100	<3 ms
RAID	$2–10	9–20 ms
Hard drive	$0.8–2	9–20 ms
Optical (single platter)	$1–4	50–100 ms
Optical (jukebox)	$.4–1	15–30 seconds
Tape (single)	$.4–2	30 seconds to 3 minutes
Tape (autoloader)	$.05–1	1–5 minutes
Tape (archived, off-site)	$.05	Hours

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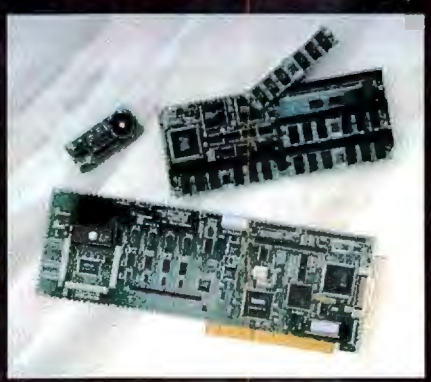
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Greg Lobdell, lead product manager for Microsoft's business systems division, says that this isn't difficult if the operating system supports object management. The tougher problem, he says, is giving storage management routines enough "smarts" that they won't try to back up a huge file over a 9600-bps modem line or make multiple copies of the same application program or repeatedly back up linked objects that have not changed.

Windows NT and NetWare 4 offer locationless network services today, Lobdell says, and "tomorrow, we'll have locationless information access." However, he adds, making storage a more readily available resource, "puts more stress on query mechanisms and tools to help you find it." Changes that occur in the user environment to provide access to the vast wealth of interconnected global data sources will have to be accommodated in storage management systems.

Another big change could come on a more physical level: the emergence of specialized storage hardware that assumes some of the role now played by software management schemes. "Long term, I see reduced importance for file servers, the explosion of application servers and storage servers, and the rise of dedicated backup servers," says Mike Peterson of Peripheral Strategies.

One interesting development in this area is coming from Vinca. The company is evangelizing an architecture for Storage Access Networks, or SANs, which consist of intelligent storage devices connected together on their own distributed network. The idea behind a SAN is to move responsibility for file access and storage management off the file server, freeing it up to handle user requests. The result could be higher storage bandwidth, improved reliability and manageability, and greater flexibility of configuration.

The combination of distributed, object-oriented file systems and intelligent storage servers will dramatically alter the landscape of storage management, but the net result for users will be greater ease of access to information and greater data reliability, with less of a need for any human intervention.

Whether you use a GUI or some other scheme for finding and manipulating files, and whether you back up via disk mirroring, RAID, optical jukeboxes, or tape libraries, the ultimate goal of storage management is to ensure that data is there when it's required. By implementing sophisticated backup, HSM, physical resource management, and access control, you are actually making data more available than if it goes unmanaged and has the potential to be lost. And implementing centralized storage management does not contradict a movement toward distributed computing; in the words of Stan Corker, an IDC analyst based in San Diego, "Virtually, the data is distributed to clients; physically, it's grouped at servers; and logically, it's centralized." The network makes these distinctions invisible to the user. ■

Andy Reinhardt is BYTE's West Coast bureau chief. You can reach him on the Internet or BIX at areinhardt@bix.com.

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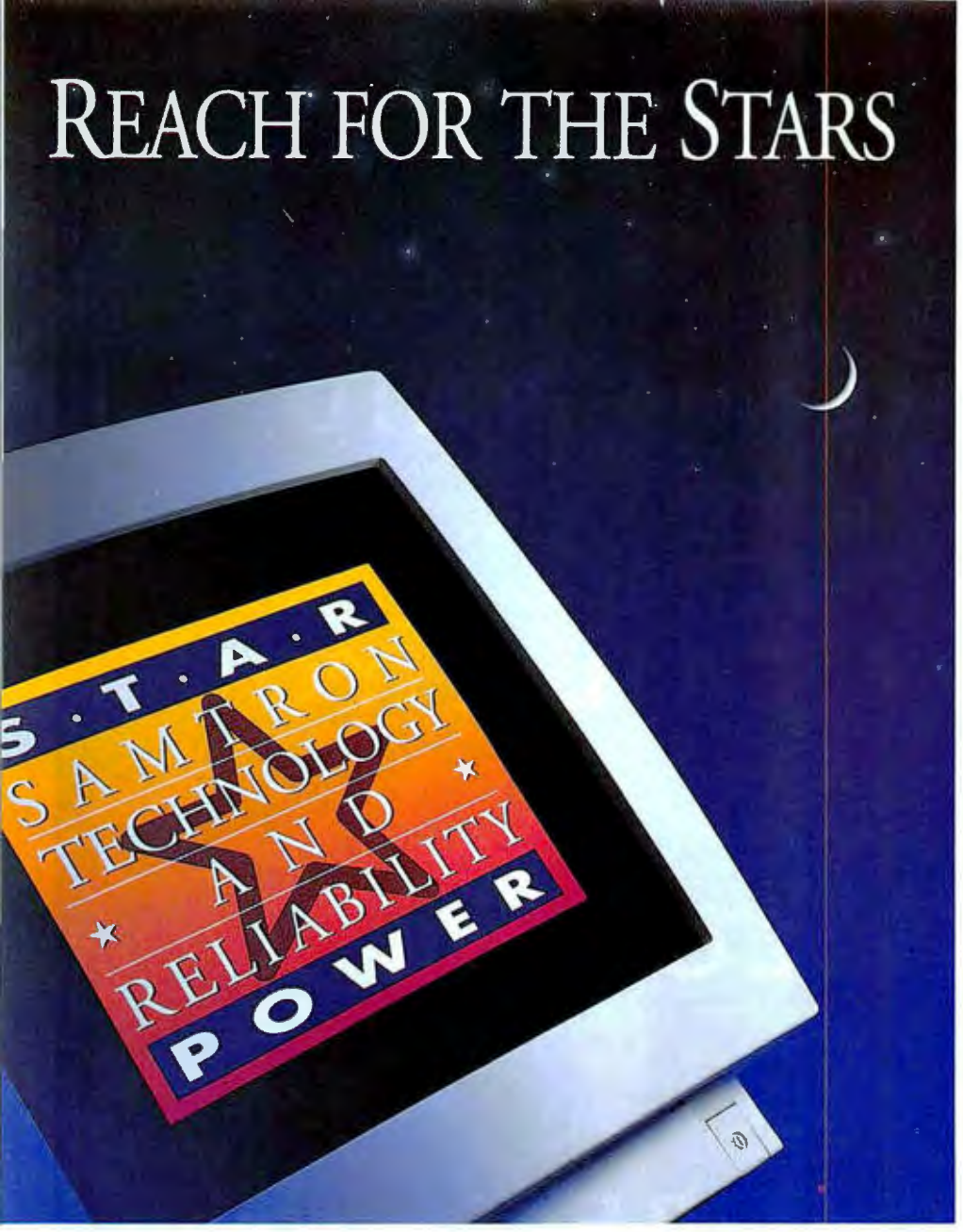
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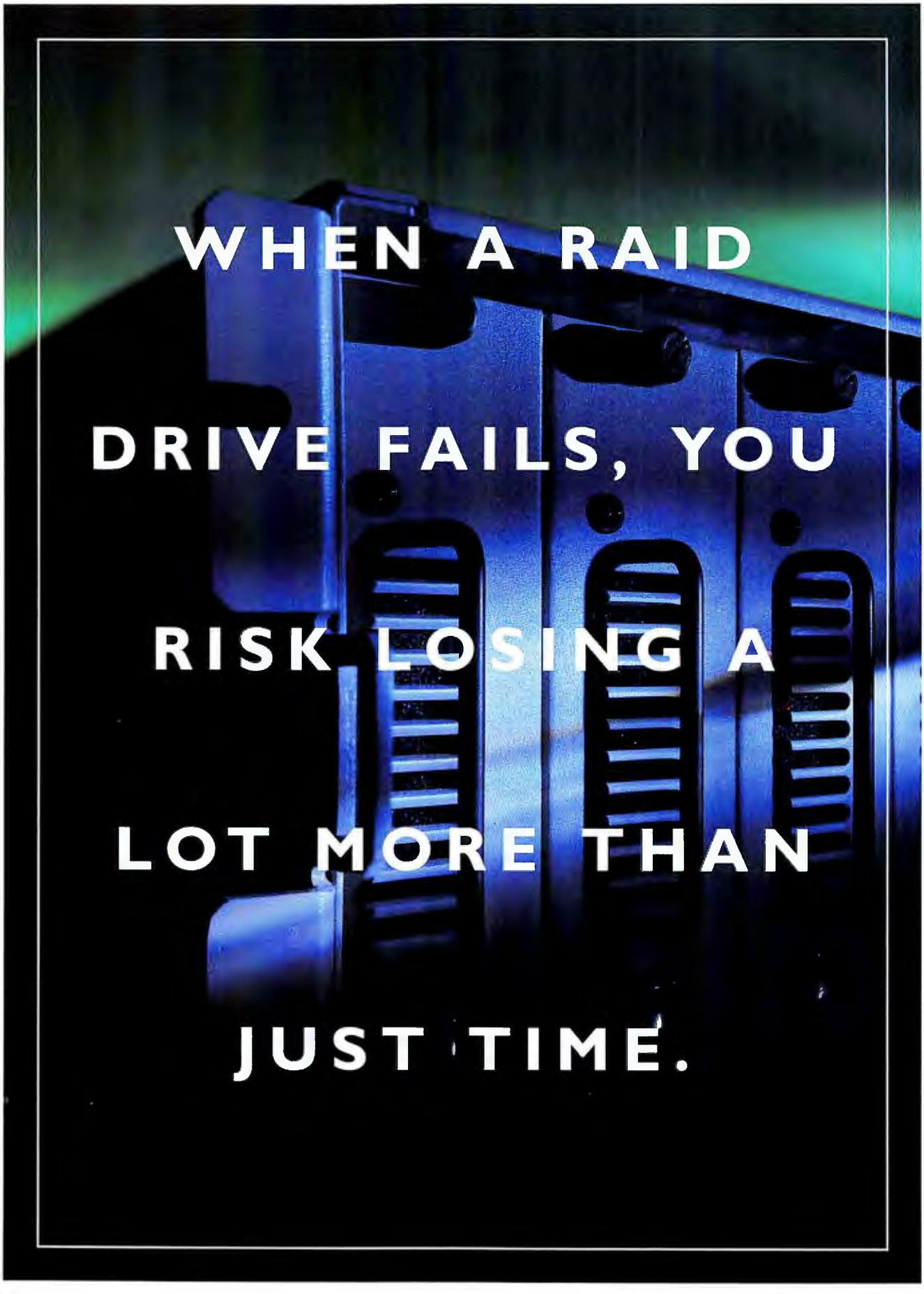
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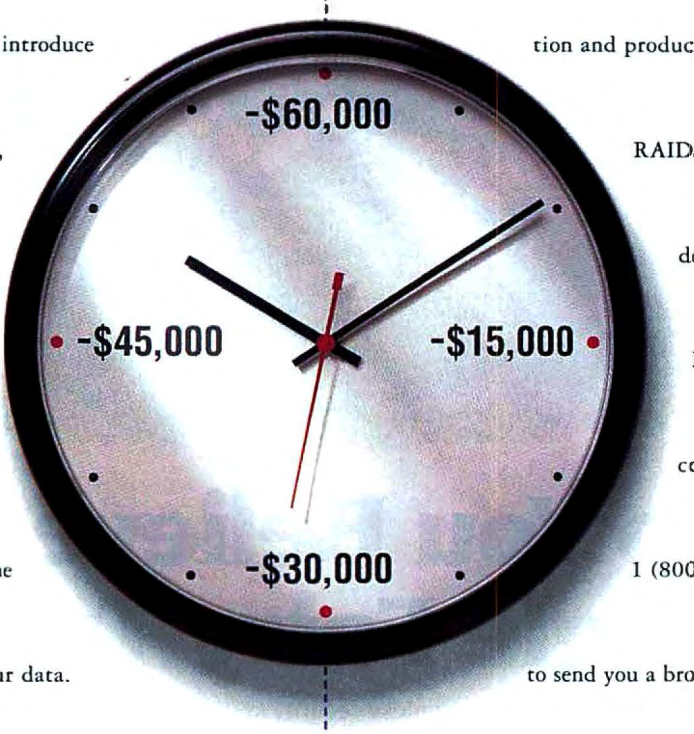

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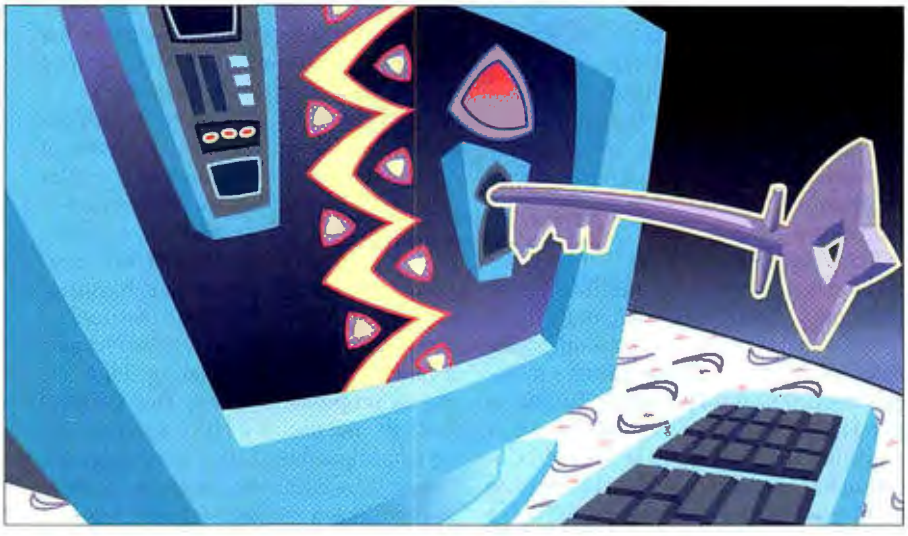


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It's ten o'clock. Do you know who is logged on to your network? Really? The fact is, as organizations of all sizes now employ networked computers and distributed systems to handle the bulk of their information-processing needs, security becomes increasingly important.

Just look at how dramatically the workplace has changed in recent years. Computers are everywhere, being used for a multitude of applications distributed throughout an organization's logical and physical structure. Electronic document interchange is replacing paper documents, E-mail is now being used in place of phone calls and memos, voice mail is taking the place of secretaries and operators, complex design and control tasks are increasingly performed using computer systems and software, and sensitive and proprietary data is routinely transmitted from network to network—indeed, from country to country—over phone lines and satellite links.

And what about the nuts and bolts? Were your distributed systems designed from the beginning as integrated wholes? Of course not. They grew via the patching together of existing workgroups, LANs of all descriptions, departmental minicomputers, corporate mainframes, and connections to outside networks. The resulting "systems" may include components using 31 flavors of Unix, plus MS-DOS, Windows (NT and Workgroup versions, too), Macintosh System 7, NetWare, TCP/IP, VMS, and MVS.

Now they're all part of the same giant network, and everyone in the company wants to get at everyone else's resources. And there's no good way of telling what kind of workstations are on your users' desks or what operating systems they are running.

At Martin Marietta Aerospace's technical computing center in Orlando, Florida, systems integrity manager Padgett Peterson watches over the security of 5000 networked PCs. He believes in active management: seeking out problem areas before they occur. "One of the biggest problems I've found is that companies don't even know how many PCs they have," Peterson says. "Some don't even have an approximate idea of how many. So they don't know who can connect to their networks."

This complexity creates many opportunities for abuse, particularly unauthorized access to confidential information. To protect the integrity of your enterprise's information, you cannot afford to take security for granted. This means controlling access and encrypting telecommunications traffic.

When you distribute information and processing, you also delegate security responsibility. Good access controls, eyes-open administration, and communications encryption can make all the difference.

Security is an issue because the majority of today's operating systems—both stand-alone and networked—were developed without any consideration for security. Either they offer no security capability whatsoever, or security and control features were tacked on as an afterthought. Software systems designed from the ground up with security as an important consideration are only now beginning to appear.

Know Thy User

When you hear the term *security*, the first thing that comes to mind is the password. And for too many organizations, a network's simple password mechanism is as far as security ever goes. Unfortunately, simple passwords offer little protection against unauthorized access; this is particularly true in a distributed environment.

When a connection comes in over a dial-up line, a

customer link, or an internetwork channel, there may be no direct way of knowing who's on the other end of the line. Thus, there is a pressing need to identify and authenticate the user at log-in time—to verify that he or she has been authorized to access your network, and to determine specifically what access rights and privileges this individual will be given.



A standard 3½-inch drive can read SmartDisk's internal circuits.

There are three different methods by which you can check on users at log-in time: by making use of something they know, something they have, or something they are. These methods are described in detail below.

The "something they know" method is typified by the user ID (i.e., the account name) and password, or by those systems that sometimes ask for other personal information, such as a person's mother's maiden name. The idea is that this is knowledge that isn't written down and is unlikely to be available to an intruder. Unfortunately, user IDs are usually easy to obtain, and people sometimes write down their passwords or even tape them to their monitor.

With the "something they have" method, which adds a second level of confidence to the authentication process, you can require that the user possess some physical object in order to gain access—the electronic equivalent of a front-door key. While this object may be as simple as a magnetic-stripe plastic card, the most common solution today takes the form of a random password generator or a challenge-response device.

One type of *token*, as these devices are called, provides a pseudo-random alphanumeric word or number that changes every minute or so and is time-synched to a stored database. This results in a one-time password that's good only at that particular point in time and for only one log-in. The first token that came to market in 1987—the SecurID from Security Dynamics in Cambridge, Massachusetts—used this system.

Another type of token is a calculator-like device into which the user types a number presented as an on-screen challenge by the host; the token generates a response that the user types into his or her workstation. Again, the result is a one-time, nonreusable password. Unless the user has the token with him or her, no log-in is possible. In addition, most of these devices can also be configured to require that the user input a personal identification number into the token prior to the authentication process.

Obviously, the use of tokens creates certain administrative problems, such as what should happen when an employee mistakenly leaves a token at home. These problems can be handled by stocking (and carefully controlling) temporary spares, but it also requires attention by a security administrator.

In addition to the tokens described above, a number of so-called *smartcard* security implementations are coming to market; these use a credit-card-size device that contains a microprocessor and writable memory. Also, NIST (National Institute of Standards and Technology) has developed a card for generating digital signatures using its proposed standard. This standard calls for the use of a NIST-patented encryption algorithm to allow the unforgeable "signing" of electronic documents to serve as proof that a message actually was sent by the claimed sender.

In addition, there is some future potential for the use in authentication applications of *active-badge technology*, in which users carry a badge that transmits a weak radio signal that is picked up by special receivers when they come within a designated range (generally several feet). The advantage to this approach is that the authentication takes place automatically, with no action on the part of the user and with no need for physical contact between the badge and the sensor.



Watchword II from Racal-Guardata is a challenge-response token.

Currently there are some 15 to 20 suppliers of smartcard- or token-based authentication systems, but one company dominates the market. In the words of industry analyst and security gadfly Winn Schwartau, publisher of the *Security Insider Report*, "There's SecurID, and then there's everyone else."

Systems that require additional hardware—such as a smartcard or a magnetic-stripe reader—have not been very successful thus far, primarily due to the inconvenience and cost of the needed hardware. Adding an extra piece of gear to a laptop system, for example, is often either wildly impractical or out of the question. One product that attempts to address these problems is Smart Cat from V One of Potomac, Maryland. This smartcard reader is about the size of a mouse and is thus stowable in a laptop's carrying case. It's price-competitive with less-capable magnetic-stripe readers, costing under $200 in quantity.

Price is likely to be a critical factor in most organizations' choice of security technologies. In the largest companies, which are more likely to have dedicated security professionals on staff and are also more likely to use token authentication, the numbers mount up quickly. You simply can't hide from the cost problem.

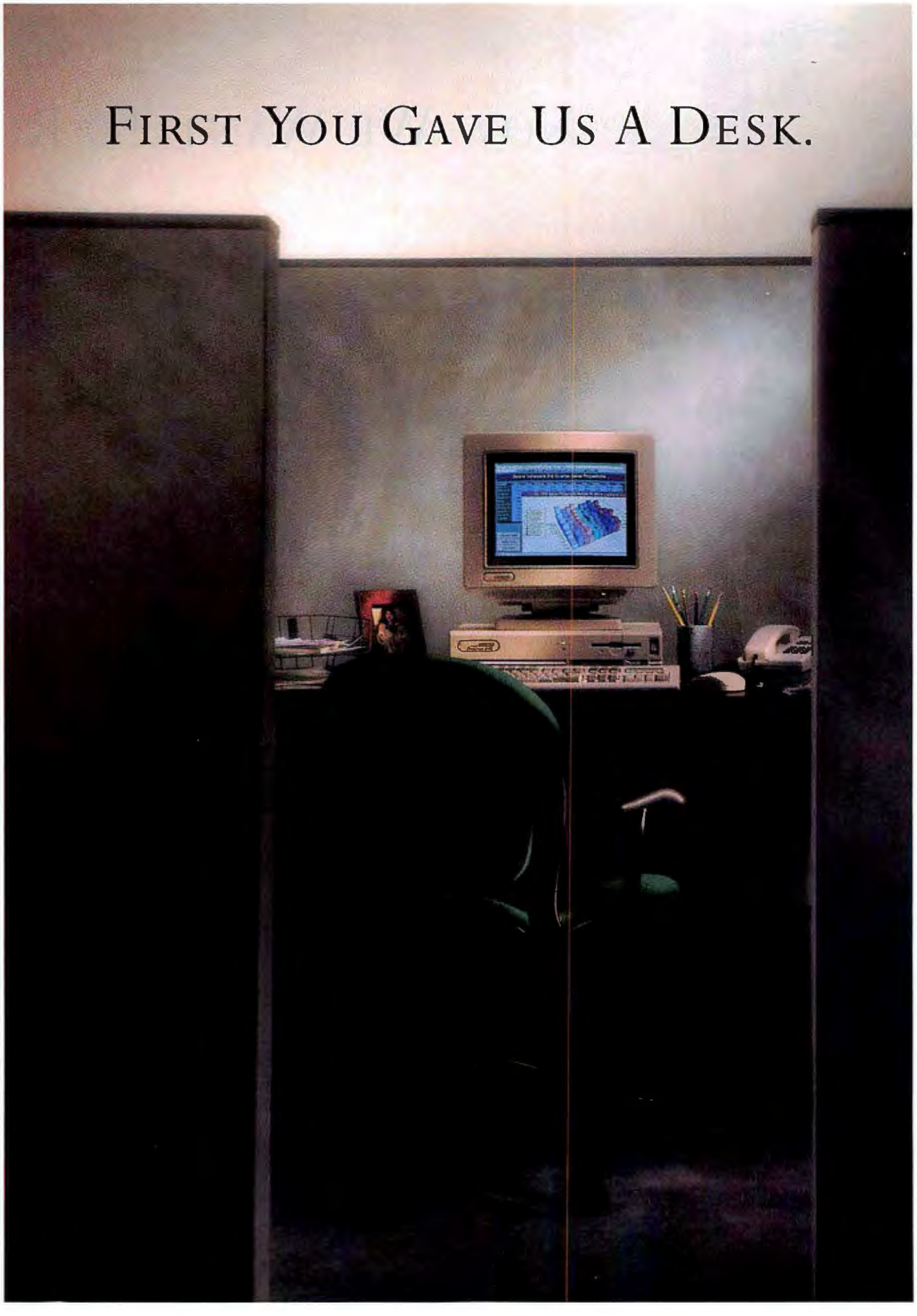
For example, Martin Marietta uses tokens at a cost of around $50 each. "The problem is," Peterson complains, "they are good for authentication, but they don't do anything else. I'd like to see them used to provide seeds for encryption." Peterson acknowledges that, in principle, smartcards and other, more capable, systems are a good idea. "But the cost of buying a reader is the stumbling block," he notes. "I don't have any problem doing this for 150 computers, but I sure can't justify it for 5000."

One recent product that addresses this objection is SmartDisk from SmartDisk Security in Naples, Florida. On the market for about a year, this $150 product packages a smartcard into a floppy disk–like unit that can be read by any standard 3½-inch floppy drive.

The final—and most secure—level of authentication, the "something they are" method, involves some unique and unforgeable aspect of an individual's body. In the past, *biometric authentication*, as it's called, has been based on comparisons of fingerprints, palm prints, or retinal patterns of the eye, or on signature verification or voice recognition. More recently, a system that recognizes keyboard-typing patterns has appeared from Los Angeles–based Phoenix Software International. Another new technology can reportedly read infrared facial patterns from passersby using only a simple video camera for image capture; it's being developed by Neurometric Vision Systems of Deerfield Beach, Florida.

Biometric systems offer the greatest degree of confidence that the user actually is who he or she claims to be, but they are also generally the most expensive to

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implement: At a cost of several hundred to several thousand dollars per reader station, they may be better suited for controlling a doorway or other physical access—where one biometric unit can serve for many employees—than for one-to-one workstation access. Another problem is that many biometric devices carry a high price in terms of inconvenience; for example, some systems can take 10 to 30 seconds to verify an access request. Moreover, resistance is high for many systems that users see as unduly intrusive; people are reluctant to stick a finger or a hand into a slot, or sign their name, or sit still while an optical system scans their eyeball.

Hiding Authentication Information

One of the principal advantages of tokens is their ability to transmit over a network an access code that cannot be sniffed and contains no reusable information. These are crucial features, but they are not limited to hardware; software systems can do the same thing. In fact, the NSA (National Security Agency) recently placed a large order for what it calls "sniffless password generators" with Secure Computing in Roseville, Minnesota.

With the company's Lockout system, instead of sending a password over the wire "in clear," you send a cryptographic representation of it, using a one-time encryption key. Each time you log in, the password is encrypted with a different key. The NSA will use Lockout in conjunction with its Tessera Crypto Card, a PCMCIA device. Intended for secure messaging within the Department of Defense and for protecting "sensitive but unclassified" data, Tessera is available from several makers. It uses both NIST's Digital Signature Algorithm and the NSA's Mosaic encryption algorithms.

Kerberos

Kerberos is an encryption-based system designed to authenticate users and network connections (see the text box "How the Kerberos Protocol Works" on page 172). It was developed at MIT's Project Athena in the 1980s and is named after the three-headed dog of Greek mythology that guards the entrance to Hades. Like its namesake, Kerberos is charged with preventing unauthorized access. It does this so well that it is now almost a de facto standard for effecting secure, authenticated communications across a network. Kerberos assumes it's in a distributed environment of unsecured workstations, moderately secure servers, and highly secure key-distribution machines.

Perhaps most significant is the fact that the Open Software Foundation's DCE (Distributed Computing Environment) standard uses a variant of Kerberos V5 as the mechanism for user authentication. Hundreds of vendors have licensed DCE technology, and many are adding additional security features (see "DCE: Building the Distributed Future" on page 125).

Another organization that's supporting Kerberos is the OCSG (Open Computing Security Group), a specialized systems integrator located in Redmond, Washington. OCSG is providing comprehensive Kerberos packages that support a number of different computing platforms, including MS-DOS, the Macintosh, SunOS, Hewlett-Packard's HP-UX, NextStep, and IBM's AIX for the RS/6000.

The OCSG integrates Kerberos with RSA (Rivest-Shamir-Adleman) public-key encryption and other security technology, including Security Dynamics' SecurID token. Other vendors offer Kerberos implementations for DEC's Ultrix and VMS platforms, and IBM says that it is committed to offering Kerberos on its MVS mainframes and OS/2 desktop systems. And, of course, you can get source code from MIT.

For all its popularity, however, Kerberos is not a complete security solution. "Too many people think that Kerberos is the answer," says Brian Redler, director of security and operations for NSCC (National Securities Clearing Corp.) in New York City. He observes that while Kerberos provides user authentication, it does not handle authorization for applications or for transactions within applications. Any determination of access authorizations and rights must be handled by other systems on the network.

Also, adapting applications systems to take advantage of Kerberos authentication—what's being called *Kerberization*—is neither simple nor straightforward; many organizations may find it well-nigh impossible and turn to other solutions. For large corporations, rolling out Kerberos across their enterprise-wide networks may not be finished in this century. Fortunately, it appears that the major networking-related vendors—including suppliers of network management software, operating systems, bridges, routers, multiplexers, and terminal servers, as well as the major computer manufacturers, including DEC, HP, IBM, and Sun Microsystems—

Security Tips for Distributed Networks

Awareness

- Establish an organizational policy regarding computer access, information ownership, and user responsibilities.
- Make users aware of their personal accountability for protecting the organization's information.

Access

- Take extra precautions if you allow dial-in (e.g., use callback modems and permit external access only through a "fire-wall" system).

Authentication

- Passwords should expire at regular intervals.
- Use tokens or smartcards as random password generators.

Confidentiality

- Encrypt data transmitted over the network.
- Encrypt stored files for especially sensitive and/or critical data.

Administration

- You must be able to administer security (e.g., add, drop, or revise access authorizations or access-control lists) from a workstation anywhere on the network.

Availability

- Prepare for power outages or brownouts with uninterruptible power supplies for servers.
- Ensure that data can be backed up and is recoverable on-line (e.g., via RAID or hot swapping).
- Maintain backup files at remote, off-site locations.
- Make sure that the rest of your systems keep going if a disk or server crashes.

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How the Kerberos Protocol Works

Kerberos is a system that uses electronic tickets to authenticate a user to a server. A *ticket*, which is good only for a single server and a single user during a certain period of time, is an encrypted message containing the name of the user and server, the user's network address, a time stamp, and a session key. Once the user gets this ticket, he or she can use it to access the server as many times as desired until the ticket expires. The user cannot decrypt the ticket but can only present it to the server. Nobody listening in on the network can read or modify the ticket as it passes through the network without detection or invalidation.

The Kerberos protocol involves two servers, the Kerberos Authentication Server and one or more TGSes (Ticket-Granting Servers). The steps involved in the Kerberos process are as follows.

1 To obtain a ticket to a particular target server, the user first requests from the Kerberos Authentication Server a ticket to the Kerberos TGS. This request takes the form of a message containing the user's name and the name of his or her TGS (there can be several).



2 The Authentication Server looks up the user in its database and then generates a session key to be used between the user and the TGS. Kerberos encrypts this session key using the user's secret key (a one-way hash of the user's password). Then it creates a TGT (ticket-granting ticket) for the user to present to the TGS and encrypts the TGT using the TGS's secret key (which is known only to the Authentication Server and the TGS). The Authentication Server sends both of these encrypted messages back to the user.



3 The user decrypts the first message and recovers the session key. Next, the user creates an authenticator consisting of his or her name and address and a time stamp, all encrypted with the session key just generated by the Kerberos Authentication Server.



The user then sends a request to the TGS for a ticket to a particular target server. This request contains the name of the server, the TGT received from Kerberos (which is already encrypted with the TGS's secret key), and the encrypted authenticator.

4 The TGS decrypts the TGT with its secret key and then uses the session key included in the TGT to decrypt the authenticator. It compares the information in the authenticator with the information in the ticket, the user's network address with the address the request was sent from, and the time stamp with the current time. If everything matches, it allows the request to proceed.

The TGS creates a new session key for the user and target server and incorporates this key into a valid ticket for the user to present to the server. This ticket also contains the user's name, network address, a time stamp, and an expiration time for the ticket—all encrypted with the target server's secret key—and the name of the server. The TGS also encrypts the new user-target session key using the session key shared by the user and the TGS. It sends both messages to the user.



5 The user decrypts the message and extracts the session key for use with the target server. The user is now ready to authenticate himself or herself to the server. He or she creates a new authenticator encrypted with the user-target session key that the TGS generated. To request access to the target server, the user sends along the ticket received from Kerberos (which is already encrypted with the target server's secret key) and the encrypted authenticator.



Because this authenticator contains plaintext encrypted with the session key, it proves that the sender knows the key.

are all hard at work Kerberizing their products. A few of these are already up and running.

With its Unicenter multivendor network security and management product, CA (Computer Associates International), one of the world's largest software companies, wants to become a major player in DCE security technology based on Kerberos. Unicenter uses DCE security mechanisms to implement basic authentication, password management, message encryption, and access-control lists. CA's stated goal is to allow customers to administer Kerberos from their current CA products while also providing security features and functions that Kerberos does not. CA plans to provide Kerberos authentication information to its existing security products, including CA-ACF2 and CA-Top Secret. The first such product scheduled is CA/Unicenter for Unix.

Knowledgeable users seem to agree that Kerberos is not quite here...yet. "To date, I am not aware of *any* applications that have been Kerberized," says Brian Redler. He adds, "Kerberos is potentially half the answer. It's a good system, but it's not enough."

Martin Marietta's Peterson agrees with Redler. "Kerberos is a good technology, but it's not really available to be used at this point," he says. He adds that Kerberos

Just as important, encrypting the time of day prevents an eavesdropper who records both the ticket and the authenticator from replaying them later.

6 The target server decrypts and checks the ticket and the authenticator, also checking the user's address and the time stamp. If everything checks out, the server now knows the user is who he or she claims to be, and the two share an encryption key that they can use for secure communication. (Since only the user and the server share this key, they can assume that a recent message encrypted in that key originated with the other party.)



7 For those applications that require mutual authentication, the server sends the user a message consisting of the time stamp plus 1, encrypted with the session key. This serves as proof to the user that the server actually knew its secret key and was able to decrypt the ticket and the authenticator.



Editor's note: *This text box was adapted from* Applied Cryptography: Protocols, Algorithms, and Source Code in C *by Bruce Schneier (Wiley, 1993).*

provides an authentication envelope, but it still requires the prior exchange of keys. "I would hope that we could have automatic, secure authentication of transmissions," says Peterson.

"Kerberos is out there for real; it's a workable solution," says John O'Leary, director of education for CSI (Computer Security Institute) in San Francisco. "Once the environment becomes large, though, the added traffic of getting Kerberos tickets can be a real issue. If you have plenty of bandwidth and high-speed links, then you'll be OK," he concludes.

Single Sign-On

Back when you were hooked up to just one system, you needed only one password. But in today's environment, a user may well need access to several mainframes, a corporatewide network, one or more LANs, special development systems—you name it. Thus, a single user can end up with seven or eight passwords or more. But that's where the password system breaks down completely. No one can remember 15 passwords, all different, none in the dictionary, all unguessable.

Wouldn't it be ideal if you could log on to a system once, and, for the rest of that session, any other systems or networks you connected to would check with a security database to determine your rights, with no need for any further log-ins, interruptions, or passwords? *Single sign-on*, as this idea is called, is the holy grail of access control. And, as with the Holy Grail, people are still searching for it. The main problem comes back to the multiplatform, multiple-operating-system, multiprotocol environment, where single sign-on is extremely difficult to implement.

"If you're on an MS-DOS workstation connected to a Novell network, and you want to access a database running under MVS on an IBM mainframe," says CSI's O'Leary, "something has to sign you on to that mainframe and pass *its* security checks." But the problem gets worse. "If you want something on a still-different platform, say a VAXcluster, now you've also got to sign on to the VAX. Each of these systems has a different security architecture, different security mechanisms. And something has to do that sign-on and maintain a database indicating what ID on platform A equates to a different ID on platform B," continues O'Leary. And there's more: "The single sign-on mechanism has to update this information at appropriate frequencies—whatever is called for by the mainframe security systems, for example," he adds.

Keeping Secrets

Even when access controls are tight and well maintained, you need one further control mechanism to ensure that your organization's information remains confidential while it is moving around the loose confines of your distributed system, or to or through other networks. As long as your system sends data between users and servers "in clear," it is vulnerable to wiretaps and network sniffers. The use of cellular and microwave links makes it even easier for a technically sophisticated outsider to listen in on your communications and your calculations.

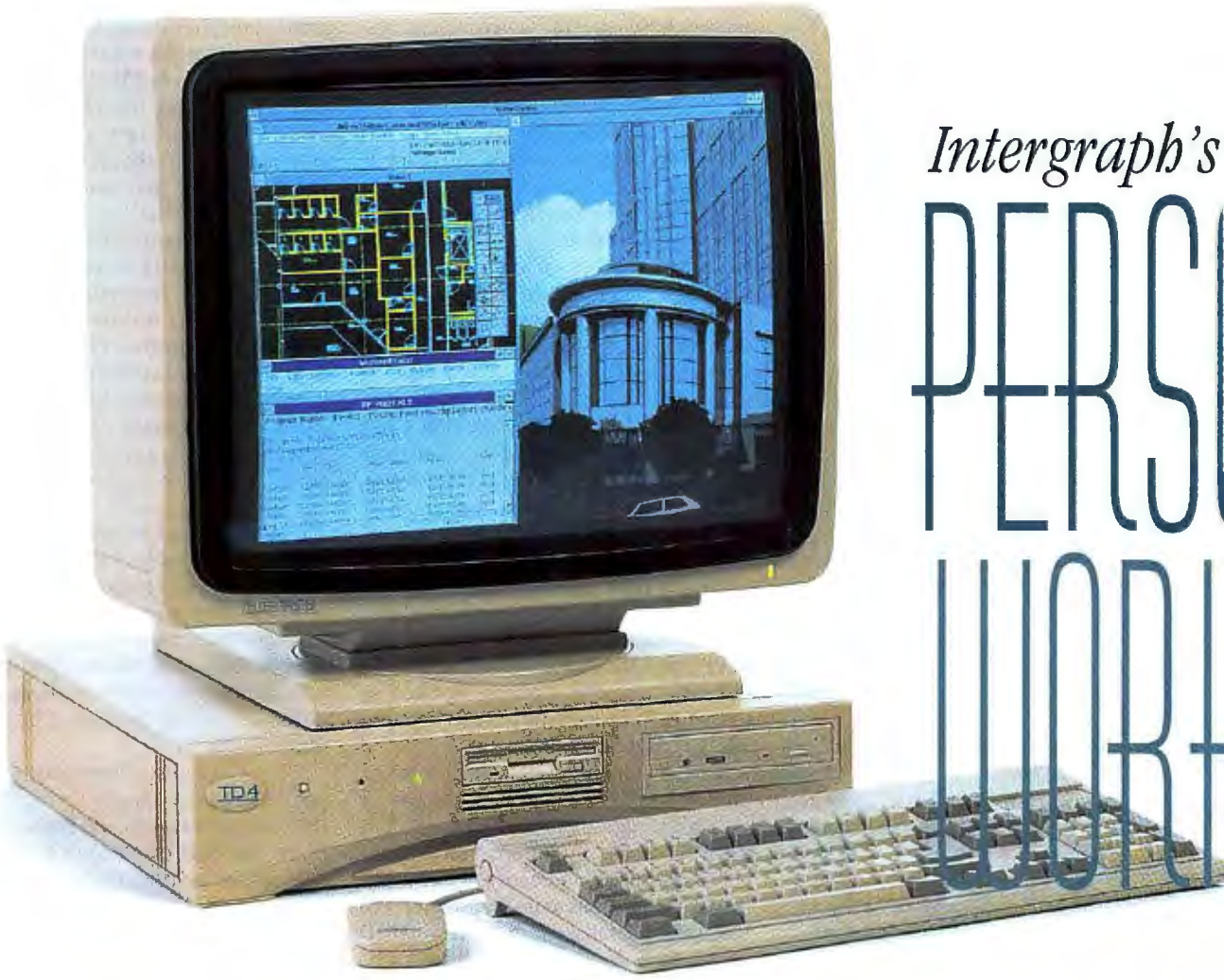
The solution to this problem is well known: encryption. You just transform the signal so that anyone who intercepts it, no matter how they do so, simply can't read it. A variety of commercially available systems use the federal DES, public-key cryptography with the RSA method, and numerous proprietary algorithms. Encryption is relatively inexpensive to buy and can be quite easy to use.

But if encryption's so good, why isn't everybody using it? The problems with encryption lie in the secure exchange and management of encryption keys. This is such a headache that one of the reasons the public-key approach was invented was to overcome the problem of key management by using one key for encryption and another for decryption. This lets the sender encrypt a message using the recipient's public key, which need not be kept secret and is, in fact, usually easily available. The message can be decoded only with the recipient's secret, or private, key.

Public-key cryptography also allows relatively simple implementations of digital signatures, nonrepudiation, and message authentication. These can be achieved with other cryptographic methods, but the public-key approach seems to be the simplest overall.

One major obstacle to acceptance of public-key cryptography is the fact that RSA, the best-known and strongest algorithm, has been patented in the U.S. and thus cannot be used in the U.S. without permission from RSA Data Security of Redwood City, California. Consider PGP (Pretty Good Privacy), a highly regarded public domain cryptographic system that was created by "cipherpunk" programmer Philip Zimmermann and popularized on the Internet. It's used around the world but is currently illegal in the U.S. because it uses the RSA algorithm without a license.

A new stage in encrypted communications may soon begin with the advent of the NSA-sponsored Clipper encryption chip for voice telephones. Clipper's inclusion of an escrowed "law-enforcement" back-door key has generated considerable controversy in the political, libertarian, and academic communities. Less well publicized, but following close behind,



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is Capstone, an extension of Clipper that includes data transmission.

As an aerospace contractor, Martin Marietta's computing activities make extensive use of communications encryption. The company's Padgett Peterson uses ViaCrypt, a $100 RSA-based (and licensed) package from ViaCrypt of Phoenix, Arizona. He also has some strong views about the Clipper controversy. "The thing with Clipper is, people react as if Clipper will give them less privacy than they have now. But they have *none whatsoever* at the moment, so it isn't really taking anything away at all," he says. He also notes that now, if you want any kind of secure phone transmission, your only option is AT&T STU-IIIs (secure telephone units), which

COMPARATIVE SECURITY OF NFS AND AFS

Feature	Network File System	Andrew File System
ARCHITECTURAL MODEL	Client/server; each file server managed independently	Truly distributed; administration by cell—file servers and clients that form a logical administrative unit
SECURITY MECHANISMS	Based on unencrypted user IDs, trusted users, and hosts	Kerberos authentication; Authentication Server process, Protection Server process
SECURITY DURING RECONFIGURATION	Users lose access to files during reconfiguration; file-system moves require changes to mount point	Reconfiguration doesn't affect users; files are accessible during moves, and filenames don't change
SECURITY ADMINISTRATION	Only system administrator can set up and maintain protection groups—sets of users with common access rights to specific groups of files	Users can create groups
ACCESS CONTROL	Uses standard Unix chmod command and mode bits on files and directories; offers only read, write, and execute rights to files and directories	Access-control lists allow fine control granularity by groups and individuals; supports read, lookup, insert, delete, write, lock, and administration rights; applied by directory only
AVAILABILITY	No standard data replication	Read-only replication per volume allows users to access a different replica in the event of a server crash
INTEGRATION WITH KERBEROS	Possible, but difficult	Integrates tightly
BACKUP	Standard Unix backup; file system inactive during backup; no cloning means system administrator must perform all restores; can use cachefs	No system downtime during backup with AFS Backup Server; volume clones allow limited user-controlled restores
FILE CACHING IN LOCAL STORAGE	Constant caching of file attributes slows performance on WANs	Automatic notification of file changes cuts unnecessary network traffic

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Dot Pitch (mm)	0.28	0.28	0.26	0.28	0.28	0.27	0.26
Hor. Freq. (KHz)	30-38	30-50	30-62	30-62	30-65	30-65	30-85
1600 x 1280 NI	—	—	—	—	—	—	Yes(60Hz)
1280 x 1024 NI	—	—	—	—	Yes(60Hz)	Yes(60Hz)	Yes(75Hz)
1024 x 768 NI	87Hz/I	60Hz/NI	75Hz/NI	75Hz/NI	75Hz/NI	75Hz/NI	75Hz/NI
Mac Compatibility	—	—	Yes	Yes	Yes	Yes	Yes
Flat Square	—	—	—	Yes	Yes	Yes	Yes
Color Match	—	—	—	—	—	Yes	Yes
Digital Controls	—	—	—	—	Yes	Yes	Yes
MPR-II & ISO9241-3	Yes	Yes	Yes	Yes	Yes	Yes	Yes
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cost $2000 per telephone.

Public law mandates that government information be protected in its processing and storage. DES has been used for this purpose for 15 years, and it has just been renewed for another five years. "People say that, well, it's theoretically possible to break DES if you have a known plaintext," Peterson comments. "But the fact is, no one has yet broken DES, and it's available for free. It's good enough for government work, just as Clipper is good enough for government work."

Administration: The Hidden Costs

Whatever type of security you have installed on your distributed systems, you still have to administer it—adding new people, taking off those who leave, modifying rights and permissions as job requirements change. And for many security administrators, the move to distributed systems has created a major administrative headache.

"What's happened as systems have become distributed and information has become distributed [is that] different departments are responsible for different platforms," notes NSCC's Brian Redler. "Mainframe administration is handled by a different group than handles the LANs—in fact, a different person may administer each LAN. And in most cases, security isn't handled by the security department but is out in the user departments, where the LAN administrator is also the security administrator."

Responsibility for communications security is similarly distributed, Redler continues. "Once, all communications came into a central location, where a well-trained network staff monitored it. Now, it comes into the corporation all over, without any central administration," he says.

All this decentralized responsibility can create a security nightmare. Redler, along with most computer-security professionals, believes that security is largely a management issue, not a technical problem. "The first thing we had to get was management's buy-in to a security program, to an overall corporate policy and set of standards. If someone develops or installs a new application," he explains, "we don't want different administrators, each with their own ideas about what security is needed."

Obviously, different systems need different levels of security. A LAN with only routine word processing and spreadsheet applications may not need as much security as a production system with sensitive corporate data. Redler has established a set of security baselines for NSCC to determine how much security is needed for what information and for which systems.

Operating Systems and Consistent Security

Another factor that influences security is the choice of operating systems—in particular, network operating systems. Some have more security than others, but the primary problem, from a network perspective, is the need to accommodate multiple operating systems. This raises problems of compatibility and consistency.

"Better, more secure operating systems could have a sizable impact" on distributed-system security, according to Redler. "But it's not that straightforward, either; there are pros and cons to having your primary security in the operating system." He notes that while it would be great to buy a Unix version with a set of security features that you could pick and choose from, it could create inconsistencies that would make overall administration of security difficult.

"If you have one department that uses secure version X of Unix and another that uses secure version Y," he continues, "then each department has its own security system that works differently from the others." Instead, he tends to favor the use of an add-on, third-party security package. "Yes, it'll cost you a little more money, but now you have consistency," he adds.

File Systems

Sharing files over distributed systems requires a specially designed file system. Some are better than others, and one of the most popular has gaping security holes. Many Unix-based systems use NFS (Network File System), a file-sharing protocol for TCP/IP networks that was created by Sun Microsystems and is now available from DEC, IBM, Novell, and others.

Using a peer-to-peer networking scheme for low overhead and simplicity, NFS processes every file access request as presented, with no knowledge of prior requests. As a result, it has no built-in record or file locking. NFS sites usually use a "lock manager" program to track file and record locks, but many client programs can simply ignore the lock manager. NFS also has no built-in security, which has led to the saying that *NFS* really stands for "No File Security." Because of its widespread use, NFS poses some serious security challenges.

The best solution to these limitations seems to be AFS (Andrew File System), developed at Carnegie Mellon University and currently available from Transarc of Pittsburgh, Pennsylvania. The designers of AFS tackled NFS's problems head-on, and the result is better security and increased reliability. Also, AFS is easier for administrators to maintain, and its greatly improved directory services simplify user access to WANs (wide-area networks).

User Awareness

It would be misleading at best to discuss distributed security in purely technical terms without at least mentioning the far larger—and perhaps ultimately more important—issue of user awareness. A certain degree of security can be imposed from above, with technical controls and administrative procedures.

But without user awareness of the risks and vulnerabilities, user cooperation, and user acknowledgment that protecting information is a part of their jobs, then security for distributed systems is a losing battle. CSI's John O'Leary puts it this way: "All the people using our systems aren't being told—or aren't listening to those doing the telling—that, in addition to the productivity enhancements their new systems and connections provide, there come some potential security downsides. People do not realize what the exposures are, and therefore they're not taking steps to mitigate them." O'Leary adds that the special problem for securing the distributed world is the lack of a single point of control. "In the mainframe world, we could rigorously and strictly limit what people had access to," he says.

What O'Leary sees as a disadvantage, however, analyst Winn Schwartau considers a plus. "With a single point of control—in single sign-on as it's usually thought of—you have reduced your security to a single point of failure," he says. He asks what happens if that point fails, and then answers: "I call that 'cyber-stupid'! Your entire system is open."

He recommends caution. "If you're going to go to this, then strengthen that point of failure. Require two forms of authentication at least—something that you know and something you own." ■

Russell Kay is a BYTE technical editor who has worked in the area of computer and information security since 1981. Before joining BYTE, he was editor of Infosecurity News *and* Computer Security Journal. *He can be contacted on the Internet or BIX at russellk@bix.com.*

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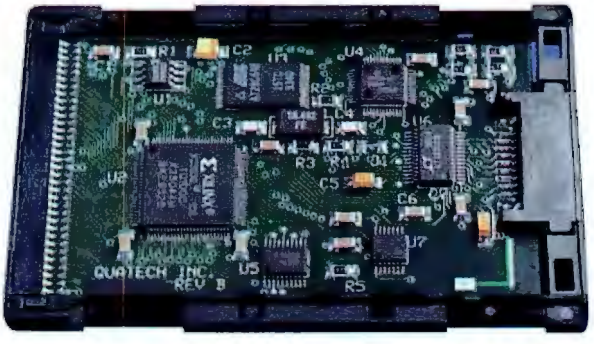
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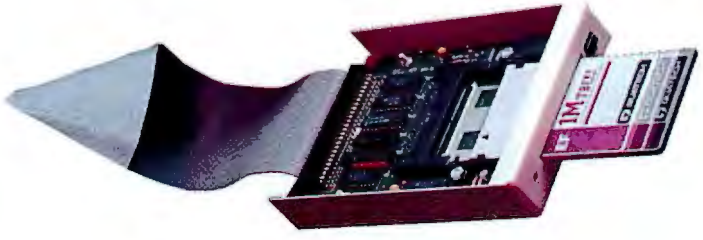
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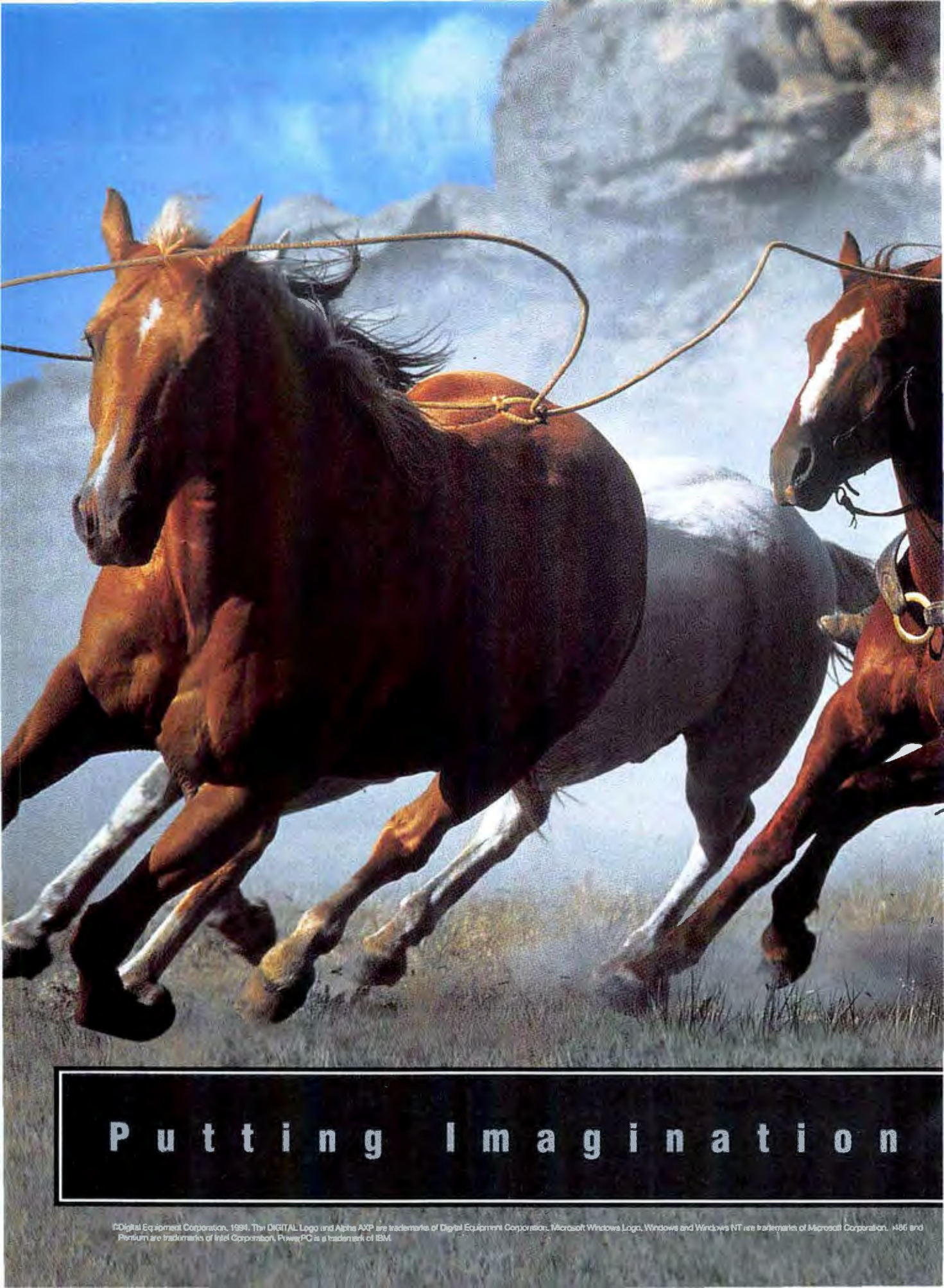
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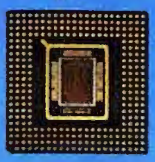
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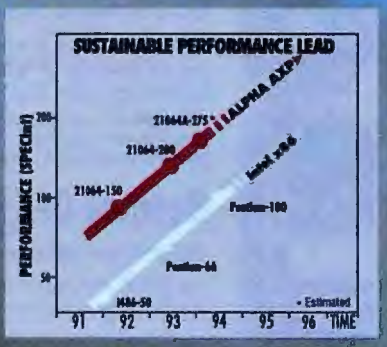


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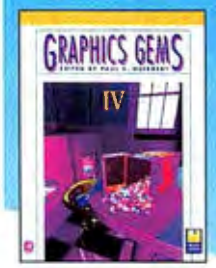
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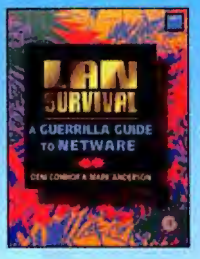
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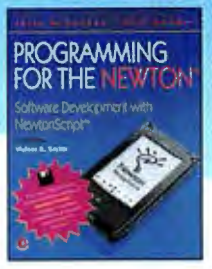














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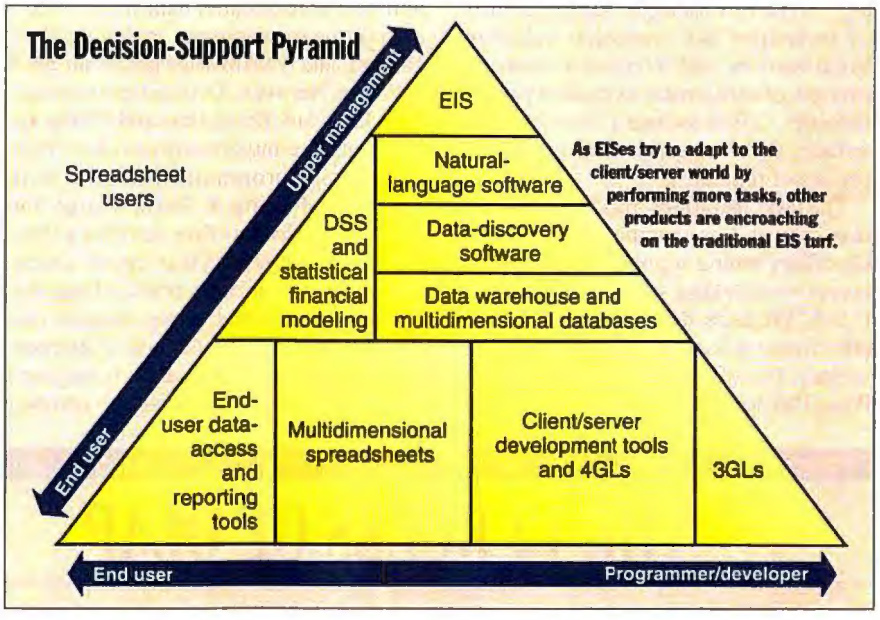
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The Changing World of EIS

KAREN WATTERSON



It used to be that everyone understood what you meant when you said "EIS" (Executive Information System). An EIS was an electronic briefing book that summarized key sales or production figures for busy executives. Early EISes tended to be custom-built by MIS staffers assigned to top-level executives.

As organizations implement more distributed client/server networks, however, decision-support applications like EIS and the related DSS (Decision Support System) have been forced to adapt. Both end-user data-access tools and client/server development tools need to analyze larger amounts of fast-changing data. This is especially true in transaction-intensive businesses like retailing and finance. And EIS/DSS must now support more than just a few executives.

Organizations spend millions of dollars collecting, storing, and safeguarding data. The challenge for today's EISes is to make that data accessible and usable to the people on the network. That means putting the tools to manipulate the data into the users' hands so they can answer their questions and understand their markets better. They don't want to go through the IS department. IS, according to Jeffrey P. Stamen, president of IRI Software (Waltham, MA), is often better being the "system police" than understanding the needs of sales and marketing departments.

The trick is to present just the information required in just the right format without rekeying summary data from massive printouts into spreadsheets. The good news is that today literally hundreds of client/server products provide reporting and querying capabilities, often at a fraction of the cost of classic host-based EISes.

But the classic EIS and DSS vendors aren't standing still. They're adopting client/server architecture, becoming more open and modular, and adding value by targeting vertical markets with special versions of their products. Most emphasize their ability to work with mammoth databases, their understanding of MIS, and their track record.

Distributed computing is forcing EIS to rethink its traditional host-based ways

How EIS Works

EISes are generally designed with two or three parts: an administrative module, where data access is managed; a builder module, where a developer sets up data mapping and builds a sequence of screens; and a run-time module that the executive or knowledge worker runs. Sometimes the first two functions are combined.

Data access and consolidation vary depending on the package. Some EISes provide their own data storage system; some only package the data and route it into a more accessible database—usually on a LAN. Some EISes do the data selection and consolidation on the host; others do it at the workstation. Some use third-party commercial middleware gateways or popular APIs like ODBC (Open Database Connectivity); others are less open, offering only a discrete list of proprietary drivers—and often at extra cost. ODBC drivers, on the other hand, are widely available, often bundled with other products. Finally, almost all of today's EISes come with a standard GUI, such as Windows, Macintosh, Motif, or Presentation Manager.

Robin McNeill, director of PowerPlay products for Cognos (Ottawa, Ontario, Canada), identifies six tasks that managers do for which an EIS will be useful: track, flag exceptions, rank, compare, trend-spot, and investigate and explore. The features most EIS tools provide reflect these tasks. They present summarized and consolidated data in both report and chart form, or they allow sequencing of screens to produce executive slide shows. Hot spots that

users can click on to get more information and other drill-down techniques help users navigate through varying levels of detail.

Exception reporting is another extremely useful technique managers use to flag data that's unusual or out of bounds. Both unusual and periodic events can be defined to trigger visual or audible alarms or activate an intelligent agent to perform a specific task. Some EIS packages support statistical techniques like regression and correlation analysis, which let you measure the strength of relationships between pairs of variables. Others include a spreadsheet interface, ad hoc queries, and batch processing of reports.

The tasks that EISes track are often mission-critical. For example, Chevron's IT subsidiary built a sophisticated $750,000 inventory-tracking system for Chevron U.S.A. Products that helps optimize the oil-refining process and minimize idle inventory. Part of that system uses Cognos's PowerPlay to show how oil moved through the supply chain during a given production week. Don Waddell, a Houston-based project manager for inventory coordination with Chevron U.S.A. Products, says, "We found the best approach for decision-support systems was to have all necessary information available on a summary basis in a consolidated system." Waddell's group used Oracle to create a data warehouse of consolidated data from diverse mainframe data sources, including IMS, Nomad, and VSAM files across an SNA (Systems Network Architecture) network.

In large law firms, time and billing applications are mission-critical. Bob Warrick, senior programmer/analyst with Pillsbury Madison & Sutro, a large San Francisco–based law firm, has built a PowerPlay 4.0 application that lets the executive group of attorneys track billing performance by practice group, location (the firm has 12 offices), and type of attorney. Time and billing information is migrated from a PowerHouse application residing on a VAX cluster to a PowerPlay database and retrieved via DECnet.

The Changing Face of EIS

Your choices for decision-support tools are confusing. Low-end (read "inexpensive") data-access and client/server tools and spreadsheets mimic much of the functionality of the classic EIS. Data warehouse and replication packages provide "safe" copies of nonoperational data that users can manipulate to their hearts' content. Smart middleware, such as InfoPump from Trinzic (Palo Alto, CA) or Micro Decisionware's Database Gateways (Boulder, CO), can be programmed to periodically download information to refresh the data sets. Client/server packages with intelligent agents can automate processes such as warning a financial analyst when a key ratio has been exceeded or sending E-mail to a purchasing manager when an inventory-reorder quantity has been reached.

Many organizations are meeting the challenge of providing direct access to corporate data on the mainframe by creating LAN-based *data warehouses* that contain read-only snapshots of host data that's periodically refreshed. This has the advantage of minimizing network traffic, expensive host CPU time, and security headaches. It also provides nonintrusive access to data in legacy systems. Some people refer to this approach as a *client/server/server system* or a *three-tier architecture*. Sometimes the data warehouse is referred to as a *data-mart* or *staging server*. Data warehouses often contain data from multiple data sources that has been consolidated and summarized. This is not on-line production data; it might be updated daily or weekly as needed. But it's real-enough time for most decision making.

Vendors such as Red Brick Systems (Los Gatos, CA) offer a different vision of a data warehouse. Red Brick Warehouse 2.1 ($20,000 and up) is an RDBMS (relational database management system) that's optimized for queries rather than data entry. Typical Red Brick clients are firms that need to analyze large amounts of data, like retailers and financial institutions. Red Brick relies on lots of indexes to allow fast retrieval of databases that average over 10 GB of

THE 12 RULES OF OLAP

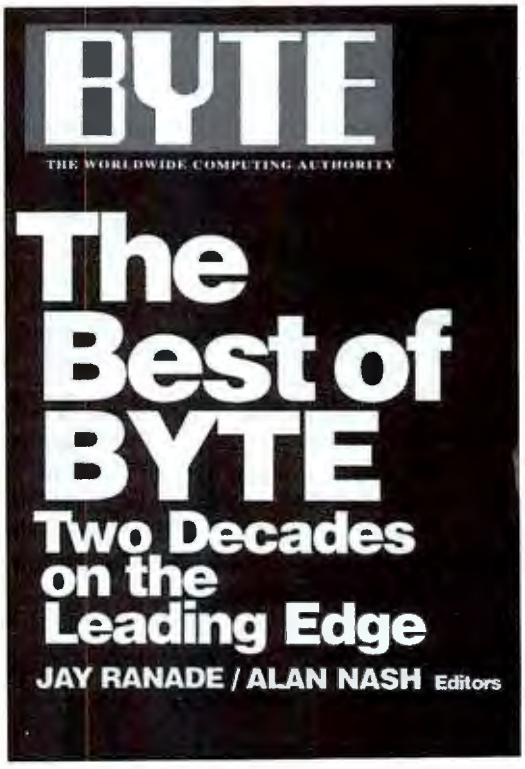
E. F. Codd, father of the relational database, and his associates have produced a white paper listing the 12 rules for OLAP (on-line analytical processing) systems. The list is fundamentally a formula for a successful information system, whether you call it an EIS, a DSS, or a business information system. For more information on the white paper, call Arbor Software, Santa Clara, CA, (408) 727-5800.

1. ***Multidimensional conceptual view.*** **This supports EIS "slice-and-dice" operations and is usually required in financial modeling.**
2. ***Transparency.*** **OLAP systems should be part of an open system that supports heterogeneous data sources. Furthermore, the end user should not have to be concerned about the details of data access or conversions.**
3. ***Accessibility.*** **The OLAP should present the user with a single logical schema of the data.**
4. ***Consistent reporting performance.*** **Performance should not degrade as the number of dimensions in the model increases.**
5. ***Client/server architecture.*** **Requirement for open, modular systems.**
6. ***Generic dimensionality.*** **Not limited to 3-D and not biased toward any particular dimension. A function applied to one dimension should also be able to be applied to another.**
7. ***Dynamic sparse-matrix handling.*** **Related both to the idea of nulls in relational databases and to the notion of compressing large files, a sparse matrix is one in which not every cell contains data. OLAP systems should accommodate varying storage and data-handling options.**
8. ***Multiuser support.*** **OLAP systems, like EISes, need to support multiple concurrent users, including their individual views or slices of a common database.**
9. ***Unrestricted cross-dimensional operations.*** **Similar to rule 6; all dimensions are created equal, and operations across data dimensions do not restrict relationships between cells.**
10. ***Intuitive data manipulation.*** **Ideally, users shouldn't have to use menus or perform complex multiple-step operations when an intuitive drag-and-drop action will do.**
11. ***Flexible reporting.*** **Save a tree. Users should be able to print just what they need, and any changes to the underlying financial model should be automatically reflected in reports.**
12. ***Unlimited dimensional and aggregation levels.*** **A serious tool should support at least 15, and preferably 20, dimensions.**

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data. Indexes are special files that work like indexes in a book. Instead of pointing to a page, they point to the exact location of a database record, based on the index field. If you index on customer number, company name, contact name, city, and area code, for example, retrieving information based on any of those fields is faster than it would be without indexes. Because of the overhead associated with maintaining the index, on-line production databases can't afford to index on all fields; data warehouses can.

Another firm, Dynamic Information Systems Corp., based in Boulder, Colorado, sells a product called Omnidex that generates indexes in your current databases (in contrast, Red Brick creates a new database). DISC also provides an API that developers can call from Windows front-end tools. Chris Werle, a business systems analyst, uses Omnidex to provide managers at Chicago-based Boots Pharmaceuticals with up-to-the minute sales and order-entry information. He likes the fact that Omnidex reduces network traffic. "Sometimes," he says, "we just want to know how many there are—to do the equivalent of a SQL COUNT. We don't need to see the records themselves at all." The project's success has prompted Boots to begin bringing previously outsourced data processing back in-house to build another EIS for marketing and sales.

Prism Solutions (Sunnyvale, CA) offers yet another angle on warehousing. Prism Warehouse Manager generates COBOL, SQL, and JCL or Script code to move legacy IDMS, ISAM, VSAM, IMS/VS, and COBOL data files into Oracle, SQL Server, Red Brick Warehouse, Non-Stop SQL, Teradata, or DB2 databases. Trinzic's InfoPump takes yet another approach, offering intelligent middleware for routing, integrating, and synchronizing dissimilar data. These warehousing, indexing, and routing products package and consolidate data that's often dispersed among multiple data sources. Ultimately, this minimizes network traffic and makes it easier for the EIS and other software to access the data.

DIMENSIONS OF EIS

The capabilities, implementation, and use of EIS vary widely. The extremes to which this is true are illustrated below.

	SINGLE USER	COLLABORATIVE
Type of report	Canned	Interactive, supports drill down
Data analysis	Internal only	Competitive analyis
Corporate planning	Tactical	Strategic
Cost	Expensive in terms of initial cost and consulting and licensing fees	Cheap enough for deployment on the desktop
Architecture	Stand-alone data-analysis tool	Integrated, part of multicomponent package
Compatibility	Proprietary	Open and modular

Replication servers are also becoming more widespread. *Replication* is related to the notion of data warehousing, but data warehouses usually contain only a subset of the data, while replicas are usually copies of an entire database. Sybase, Ingres, Informix, and Oracle sell replication servers that can keep multiple copies of the database up to date, making it easier for users who may be physically dispersed to get fast, local access to data. The industry can thank Lotus Notes for popularizing the concept of replication, since replication of Notes databases is a common activity. Like warehousing, replication makes copies of data conveniently available for access by EISes.

Another force affecting traditional EISes is that, more often than not, today's executives are computer literate. Many of them are familiar with spreadsheets, drill-down techniques, and slice-and-dice techniques for data exploration. They may not want predigested summaries.

Even more significant, though, is the trend toward flatter organizations with distributed decision making. It's no longer just executives who need access to corporate data, and, in a sense, EIS as such is really a dinosaur. Line and branch managers need sales and marketing data, and customer-service representatives need access to customer account and credit information. Classic EIS let you build static presentations for upper management. It wasn't designed for interactive, ad hoc exploration of the data. If it gave that illusion, it was thanks to the skill of the programmer who anticipated the executive's needs. "The flattening of management structures," says Frederick Lizza, vice president and general manager of Trinzic's Database Access and Connectivity Unit, "makes the limited hierarchical executive information system a relic of the past."

EIS is also feeling price pressure from spreadsheets, which have data access built into them. Spreadsheets have a wide installed base and are the tool of choice for millions of business information workers and decision makers. These users don't want to have to learn another program to do their data analysis. As spreadsheet vendors add more functionality, like pivot tables and multidimensional spreadsheets, EIS products will come under even more pressure. Multidimensional spreadsheets make it easy to answer questions that would be extremely cumbersome in SQL, such as "Give me the top three sales regions based on the percentage change in revenues this year relative to last year."

Associated with multidimensional spreadsheets is a trend that's sometimes called OLAP (on-line analytical processing). In contrast to OLTP (on-line transaction processing), which focuses on order entry and other transaction-processing systems, OLAP includes decision-making systems for marketing, sales, and finance (see the text box "The 12 Rules of OLAP" on page 184). As IRI's Stamen explains, "OLAP is a way of looking beyond transactions to the forces driving them. It can help companies accurately forecast sales in order to better plan inventory and production levels, know where advertising is working and where they're wasting millions of dollars, and determine if their products are correctly priced."

In addition to mainstream client/server and spreadsheet programs, the EIS market is being invaded by special-purpose packages, including statistics packages. SAS (Cary, NC), for example, has a SAS/EIS module. Data-discovery software—e.g., IDIS (Information Discovery System) from Los Angeles–based IntelligenceWare—uses statistical methods to find correlations in data.

The Depository Trust Company is one of the world's largest clearinghouses for the securities industry. Company executives set goals and determine tasks required to meet those goals; managers must then provide periodic status reports so that senior management can monitor progress. SAS/EIS performs this task well because it provides easy access to the firm's DB2 data without duplicating it, according to Khasha Dehnad, manager of decision support and executive information.

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Decision-Support Software

The following list describes some of the available EIS or EIS-equivalent products. For contact information, see the Distributed Computing Resource Guide on page 206.

Acumate Enterprise Solution 1.0 *Kenan Technologies*	Acumate provides a multidimensional database engine, 4GL, APIs for C, Visual Basic, and Excel, and analysis copilots or wizards for help on complex analysis functions. Acutrieve, EIS Browser, and Visual Basic and Excel client tools are optional. Cost: $25,000 for five users, including all client tools.
Commander EIS 4.0 *Comshare, Inc.*	This is a multicomponent product featuring Arbor Software's Essbase multidimensional server running on Windows NT or OS/2 (Unix coming), with Comshare's host-based System W available as an option. Desktop tools include Commander Desktop with Execu-View for end users and Builder for developers. Commander Prism ($599), which supports multidimensional modeling, is optional. Cost: $85,000 for 25 users.
CrossTarget *Dimensional Insight, Inc.*	This multidimensional data analysis and reporting tool set allows users to create reports without using predefined queries. Downloads ASCII data from host systems and permits users to access and analyze data from more than 1 million records at a time. Builder compresses, indexes, and links data, and the Diver GUI provides drill-down views. The optional Data Integrator joins dissimilar data. Runs under Windows, NT, OS/2, Unix, Mac, and VMS. Cost: $1000 average per seat.
Data Interpretation System (DIS) *Metaphor, Inc.*	IBM subsidiary Metaphor introduced DIS, a client/server decision-support workbench that runs under OS/2, in 1984. The Global Access for PC module lets Windows and DOS users access DIS as well. DIS can access OS/2 DBM, Oracle, SQL Server, OS/400, Red Brick Warehouse, DB2, Teradata, and SQL/DS data. An optional EDA/SQL Extender module is available, and there is special vertical-market support for retail and health-care firms. Cost: $20,000 (OS/2 DBM) and up. Additional fees for Global Access and Capsule Services.
EISToolKit 2.11 *MicroStrategy, Inc.*	This is a set of cross-platform tools for building EIS and DSS for Windows and Macintosh. It includes the Informix Wingz spreadsheet plus its HyperScript scripting language; SQL access; reporting tools, an API, and ODBC support from ClearAccess; and a Q+E API. Cost: $1995 for EISToolKit Designer; $7995 per 10-pack for run time.
Express/EIS 4.5, DataServer Analyzer, Brand/Sales Partners for Windows, and Express Financial Management System *IRI Software*	Express/EIS (for Windows, NT, DOS, or Motif) is a toolkit for building briefings based on Oracle, Sybase SQL Server, DB2, SQL/DS, or ALLBASE/SQL data in the Express Server or available via SQL gateways. DataServer Analyzer (Windows and DOS) targets sales and marketing users and includes predefined reports. The Partners are a pair of vertical applications for packaged-goods companies doing sales or brand analysis. Express FMS is geared toward CFOs, budget analysts, and controllers. Cost: Express/EIS, $25,000 and up for 10 users; DataServer, $3750; Express FMS, $45,000 and up for 10 users.
Focus/EIS for Windows 3.3 and EDA/EIS for Windows *Information Builders, Inc.*	Focus/EIS for Windows is an OEM version of Pilot LightShip with extra features, like DDE support. Requires PC/Focus, PC/Focus Runtime ($199), or Focus Reporter for Windows ($199), but can access any data that Focus can use. EDA/EIS requires host-based EDA/SQL (call for pricing) and provides connectivity on more than 35 platforms. Cost: $395 each.
Forest & Trees 3.1a *Trinzic Corp.*	This is a Windows desktop decision-support product providing both direct and ODBC access to most data sources, including gateways and Lotus Notes. Includes charting, drill down, alarms, and alarm triggers. Trinzic also sells intelligent middleware in the form of InfoPump and interactive access to legacy databases from InfoHub. Cost: $695.

Other applications are performing EIS-like functions. Multidimensional databases such as Kenan Technologies' Acumate (Cambridge, MA) store data acquired from external data sources much as data warehouses do. However, multidimensional databases (not to be confused with multidimensional spreadsheets, although both typically include features that support financial modeling and statistical analysis) let developers define multidimensional "views." (RDBMSes are limited to 2-D views.) EIS-like functions are also apparent in natural-language software. With Natural Language from Natural Language, Inc. (Alameda, CA), for example, once the developer defines the interface, managers can formulate questions in English (supplemented by words in other languages, if desired) rather than in SQL (Structured Query Language, a sort of

Holos *Holistic Systems, Inc.*	Holos is a complete EIS/DSS for multidimensional modeling. It supports use of multiple rule sets (e.g., pessimistic, optimistic, and normal) for flexible forecasting. Runs under Windows, Mac, MS-DOS (clients), HP/UX, AIX, Sequent, SunOS, VAX/VMS, and OpenVMS (host/server). Can access Oracle, Informix, SQL Server, Ingres, and Rdb data. Holos supports integration with E-mail and real-time data feeds such as news wires. Cost: $50,000 and up.
IMRS OnTrack *IMRS*	This financial information system uses Hyperion (Windows) or Micro Control (DOS) time-series engines that support multidimensional views. It can optionally use SQL Server. Executive Forum ($15,000) can be integrated with Lotus Notes. OnRequest, another $15,000 option, uses Forest & Trees to gain access to over 20 SQL databases and other data sources. IMRS also sells related financial packages, such as IMRS Forms ($60,000). Cost: Hyperion, $125,000 and up; Micro Control, $95,000 and up; OnTrack, $45,000 and up.
LightShip 3.3, LightShip Server, LightShip Modeler, Command Center, and FCS *Pilot Software, Inc.*	Command Center is a host-based (IBM mainframes; HP/UX, AIX, and other Unix systems; VAX/VMS; and OpenVMS) EIS supporting DOS, Windows, and Macintosh clients. The LightShip family is Windows-based. LightShip Server supports multidimensional and trend analysis, charting, and drill down. LightShip Modeler, based on FCS, focuses on financial aspects of decision support. Mapping support for LightShip using TerraLogics' libraries is available. Cost: LightShip Professional, $49,000 for 100 users; LightShip Server or Modeler, $45,000 and up; Command Center, $75,000 and up; FCS, depends on installation.
Omnidex and Omnidex for Client/Server *Dynamic Information Systems Corp.*	This indexing system provides rapid access to midrange systems, including HP Turbo/Image, DEC Rdb and RMS, Oracle data from HP 3000 and HP 9000, and DEC VAX/VMS systems. It does not replicate data. Omnidex for Client/Server provides an API for Windows. Cost: $9000 and up; Omnidex for Client/Server, $2000.
PowerPlay 3.0 *Cognos Corp.*	PowerPlay is a desktop EIS package supporting drill-down and slice-and-dice functionality. It also includes a PowerPlay Transformer that permits multiple views of multidimensional data sets created from either relational or flat-file data. Release 4.0 (due this month) will include Briefing Books for OLE-driven EIS presentations and will combine administrator and end-user modules into a single box. Cost: administrator, $795; end user, $695.
SAS/EIS 6.09 *SAS Institute, Inc.*	This Windows-based multiplatform tool features a dynamic data dictionary and tools for exception reporting, forecasting, and variance analysis. It features drill down, tracking critical success factors, and integration with other SAS tools, but it can use data from flat files and SQL data sources as well as SAS data sets. SAS/EIS requires Base SAS ($940 and up). Cost: $730.
Prism Warehouse Manager 3.5 *Prism Solutions, Inc.*	Prism Warehouse Manager generates COBOL, SQL, and JCL or Script code to move data from IDMS, ISAM, VSAM, IMS, DB2, and COBOL data files into Oracle, SQL Server, Red Brick Warehouse, NonStop SQL, Teradata, or DB2 databases. Source data can be integrated and transformed, and delta change support is also available. Cost: $100,000 and up.

Esperanto for relational databases).

Add these to the traditional DSS and high-end financial analytical modeling packages, and you've got the makings of a highly competitive—and confusing—market. "DSS and EIS systems are on a collision path with traditional reporting and workstation tools gaining EIS-like graphical features," says Ron Sella, business development manager of the Microsoft Products Division of Information Builders (New York, NY); "DSS and EIS will merge within the next two to three years." Sella points out that Information Builders' new Focus Reporter for Windows, for example, already incorporates EIS features such as drill down.

Michael Saylor, president and CEO of MicroStrategy (Wilmington, DE), which makes EISToolKit and DSS Agent 1.0 Enterprise, takes a more Windows-centric











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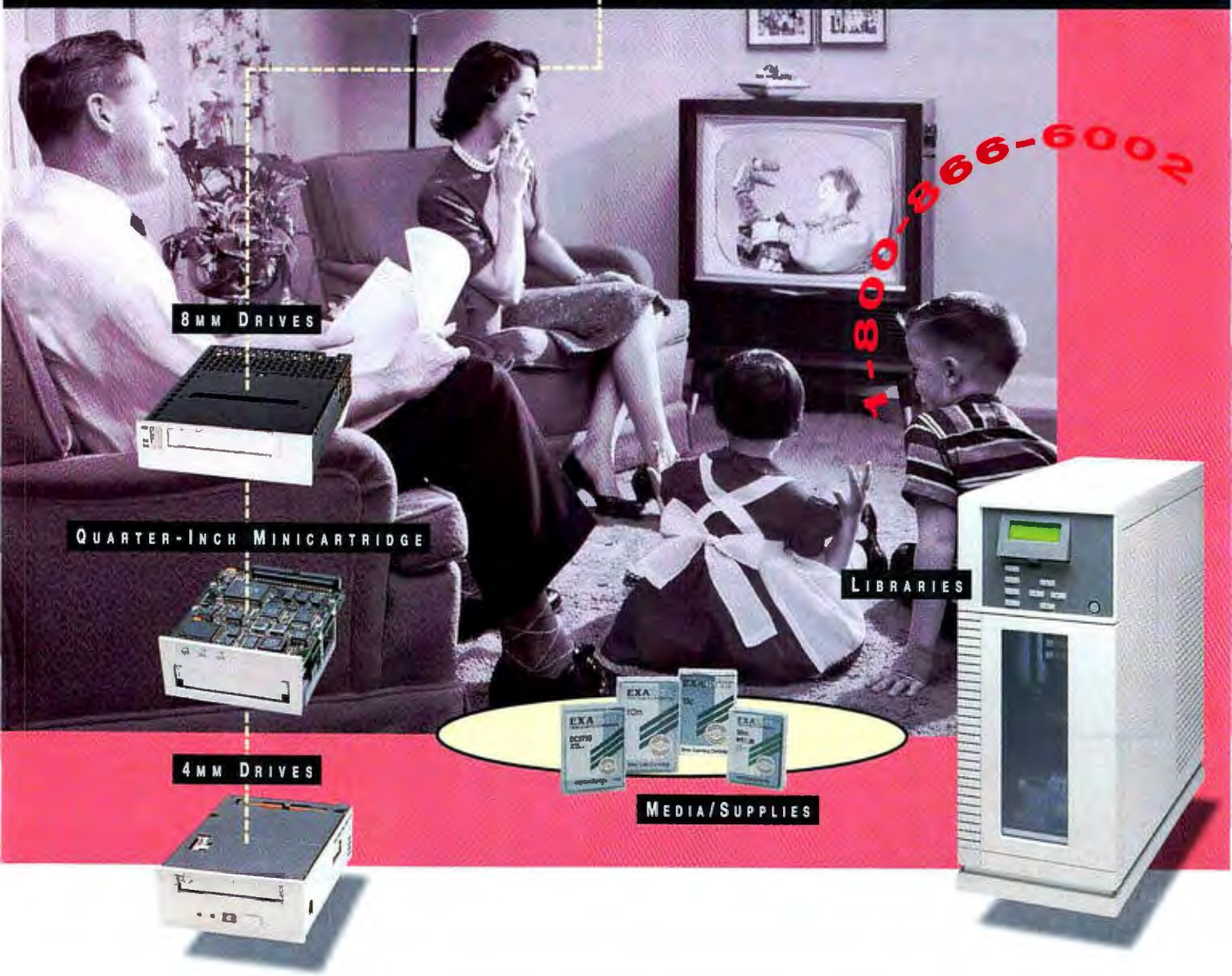
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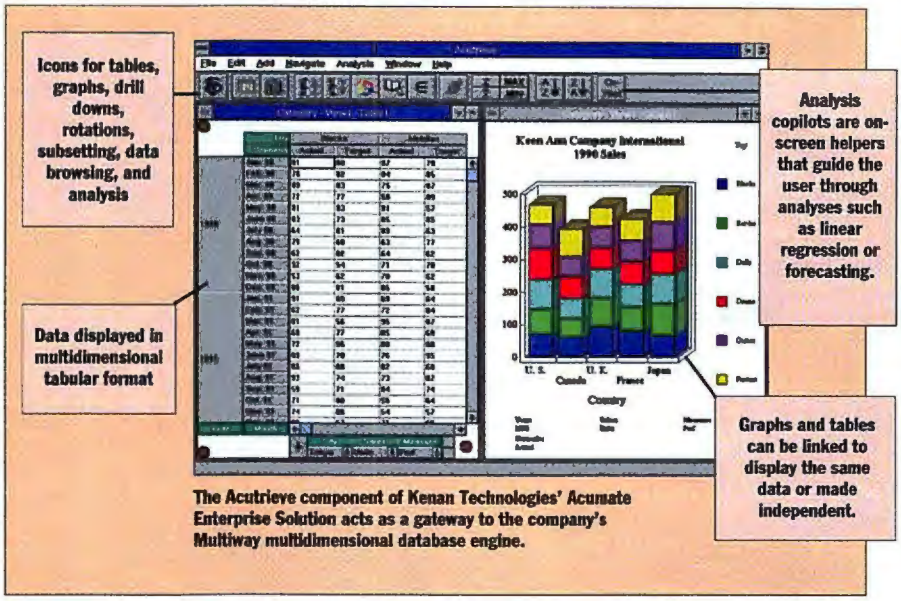
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The Acutrieve component of Kenan Technologies' Acumate Enterprise Solution acts as a gateway to the company's Multiway multidimensional database engine.

view of the market. "Up until 1993, the EIS/DSS market consisted of maybe 30 or 40 players," he says. "Imagine them playing volleyball on the beach. Then along came Bill Gates with this huge bulldozer representing Windows, complete with its APIs and Visual Basic, which essentially commodified a huge amount of EIS. This giant bulldozer was plowing along, scraping a foot of sand off the beach. Some people ran headlong into the bulldozer. Others ignored it and were plowed under. Some tried to escape into the ocean. Others tried to outrun it. Our approach is to look for the opportunities behind the bulldozer. There's a tremendous need for vertical-market applications and other new kinds of tools. Why fight the bulldozer?"

Consultants like Mark Burgess, president of San Diego–based Knowledge Works, would agree. Instead of using a commercial EIS, Burgess opted to use Visual Basic as the engine for a prototype budget-analysis EIS he built for the U.S. Air Force. Burgess's EIS application runs over a WAN (wide-area network) to access distributed data, which will probably reside in a SQL Server for NT database, using Microsoft Access for staged data.

Common Themes

All the applications competing to perform EIS tasks have some common themes. They are being used by more than one person. They use GUIs, most often Windows. Many automate what amounts to complex SQL queries as well as data consolidation and charting in a client/server framework. And that's the rub. EIS and DSS are merging, to be sure, but the bloodier battlefield will be where client/server meets EIS/DSS.

Today there are too many players, and that's a formula for industry consolidation and shakeout. Expect to see most EIS vendors shedding the EIS moniker, with new releases of their products emphasizing *enterprise*, *client/server*, *multidimensional*, *business information systems*, or *analytical processing*. Expect increasingly open and modular systems. Proprietary EIS systems are surely dying, but the death rattle may be a prolonged one, similar to that of COBOL and mainframes.

You can also expect increasing numbers of both classic and new EIS vendors to target special vertical markets. For example, IRI Software already has special software for the consumer packaged-goods market, where its parent company Information Resources does market research. Farther down the pike, you're likely to see intelligent agents that perform processes based on predefined conditions. The logical next step will be to extend automated analysis to automated decision making, according to MicroStrategy's Saylor. After that, you should see what Saylor calls *cybernetic decision making*, where only the best intelligent agents survive in a self-modifying system that is constantly perturbing and sampling its own systems. ■

Karen Watterson is the principal of the Watterson Database Group, a consulting firm based in San Diego, California. You can reach her on the Internet at 111-9390@mcimail.com or on BIX c/o "editors."

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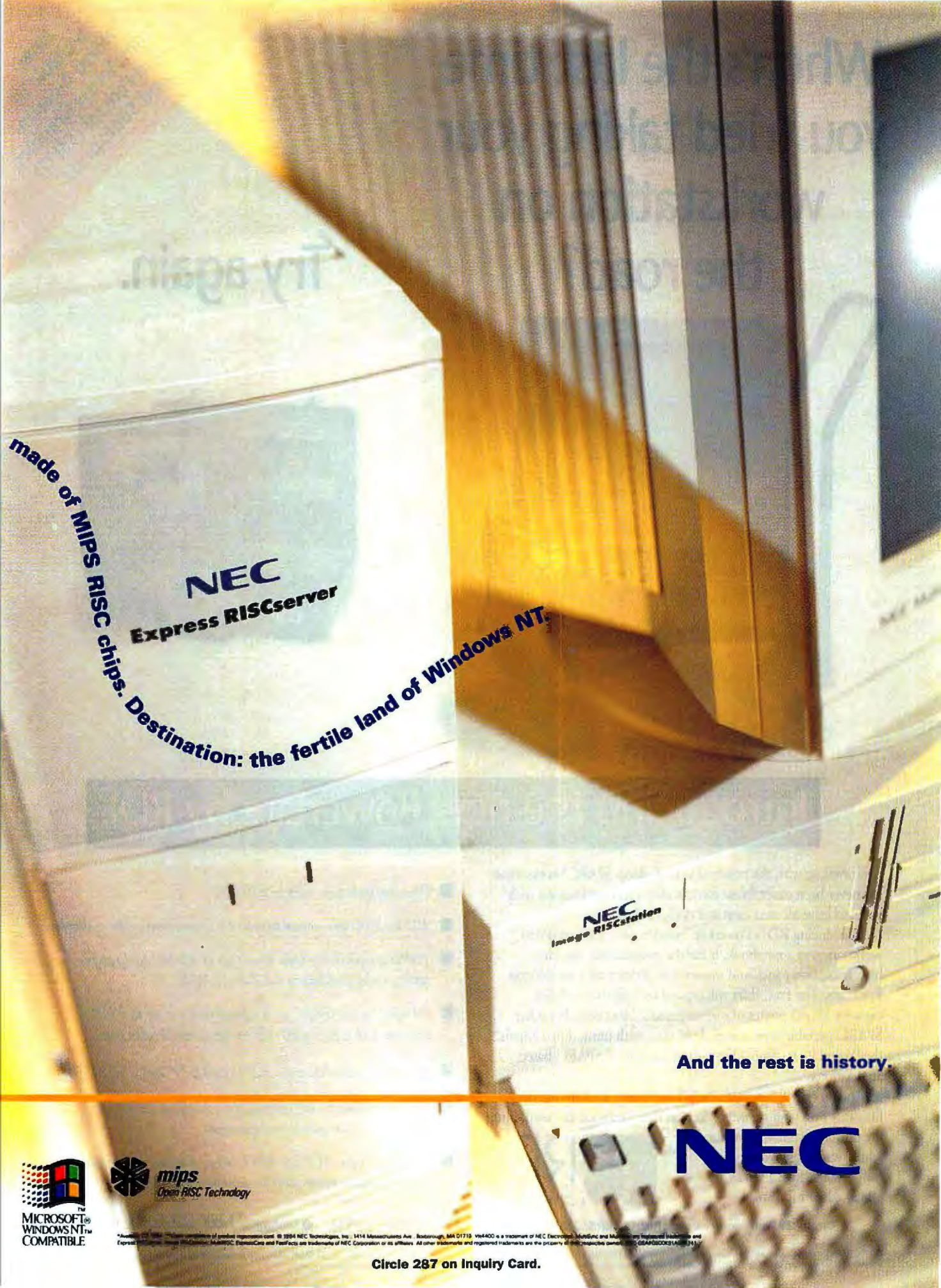
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BY364

Remote Connections

Off-site users who connect infrequently to distributed networks present unique challenges

MICHAEL NADEAU

One of the most difficult challenges of implementing distributed networks is dealing with remote clients. These clients might be workers in branch offices, people working at home, or mobile personnel using portable computers. What makes them different from other nodes on the network is that they are connected only intermittently.

This presents several problems. First, most remote links are made through a dial-in line via a modem. Phone connections are expensive, so it is critical to know how often a remote user connects and the type of data transmitted.

Second, remote or mobile employees, away from the watchful eyes of the network manager, are notorious for using unauthorized software. Controls are needed not just to ensure that the software at the remote client is legitimate, but to ensure that authorized software can be updated centrally.

Most significant, for both the business and the remote user, the database is never up-to-date. There is always some information at a disconnected site waiting to be reconciled with the rest of the corporate data. When it's finally reconciled, it must be both accurate and available in a timely manner.

Making the Connection

Remote-access software, such as Symantec's Norton PC/Anywhere and Microcom's Carbon Copy, provide access only to a local node on the network, via a slave/host relationship. They transmit the screen image of that local node to the remote client and allow for file transfer, but they do not make the remote client an actual node on the network.

Instead, off-site users commonly make the network connection by dialing in to a remote-access server using a high-speed modem or sometimes a dedicated line. A remote-access server acts as a bridge that provides remote clients a two-way connection to the network—usually via Ethernet or token ring. To the network, the client looks like anyone else on the network. The user sees no difference, either, except for slower performance caused by the smaller bandwidth of the remote connection. Most remote-access servers allow for up to eight simultaneous connections. Common features include protocol independence, built-in security, and management utilities.

Remote LAN Node from Digital Communications Associates (Alpharetta, GA) emulates an Ethernet or token-ring NIC (network interface card) in software on the remote client. The RLN product can handle an unlimited number of dial-in ports on a single phone number. RLN doesn't care what kind of network protocol you're running. On the client side, only DOS and Windows are supported, although the company plans to support OS/2 and the Mac as well.

The trusted-domain feature of RLN lets a network administrator set up access to the RLN server, so that no matter where the user is calling from, he or she logs on using the same security procedures. For example, if a branch manager travels to another company site and logs on to the local network, RLN automatically knows to authorize that person according to the security protocols of that local network.

Shiva Corp. (Burlington, MA) popularized the concept of remote servers and network modems, which effectively function as single-port access servers. Its LANRover/Plus remote servers provide four to eight ports and come with the Shiva Net Manager, which allows remote or local management of the server—an important feature if servers are installed at multiple sites. LANRover/Plus supports the Novell NetWare Bindary user security ID lists. The client part, Shiva Remote, supports MS-DOS, Windows, and Unix.

LANexpress Server from Microcom (Norwood, MA) comes with both remote-node and remote-control software. It is Windows-based and gives you a grid of simple icons representing key functions. You also get the expressWatch management software for monitoring and configuring the system.

The MicroAnnex NCS from Xylogics (Burlington, MA) provides only two ports, but at $995 it is considerably less expensive than other remote-access servers, which can cost several thousand dollars. It, too, supports NetWare Bindary security, and it comes with Xylogics' Fastlink remote-node software. Other vendors of remote-access servers include Cayman Systems (Woburn, MA), Telebit (Chelmsford, MA), 3Com (Santa Clara, CA), and Cisco (Menlo Park, CA).



ILLUSTRATION: ROBERT BURGER © 1994

The above remote-access servers have hardware and software components. Citrix Systems (Coral Springs, FL) sells applications-server software, WinView for Networks, that provides remote Windows access. WinView offers server-based processing for Windows and MS-DOS applications, sending the results only to client workstations. A 486 WinView server supports 10 Windows or 20 MS-DOS users simultaneously accessing applications running on the server. Citrix's Intelligent Console Architecture minimizes traffic by sending only Windows graphics commands and mouse and screen updates over the

dial-in connection. Except for file transfers, Citrix claims near-network performance for remote nodes. WinView also supports remote-access servers from Novell, Digital Communications Associates, Shiva, and 3Com.

Performance bottlenecks over dial-in connections are a fact of life for remote users, but you can minimize them. Using a fast modem—28.8 Kbps or higher—with the latest compression algorithms is the easiest way to boost transmission speed. Ultimately, though, the greatest gains are achieved by the distributed applications themselves. "The trend is to design applications that are bandwidth-sensitive," says Mark Monday, the RLN product manager.

Applications need to be aware of when there is a slow connection to the network and then act to minimize the traffic over that connection. This most likely means keeping more of the data at the server and running more of the application at the client.

Also, performance is only as good as the slowest link. This point is especially critical with notebook PCs. A high-speed modem won't do much good if it's attached to a slow serial port on a notebook. You want to equip mobile clients with notebooks that have high-speed serial ports and modems that can take advantage of them.

Managing Remote Clients

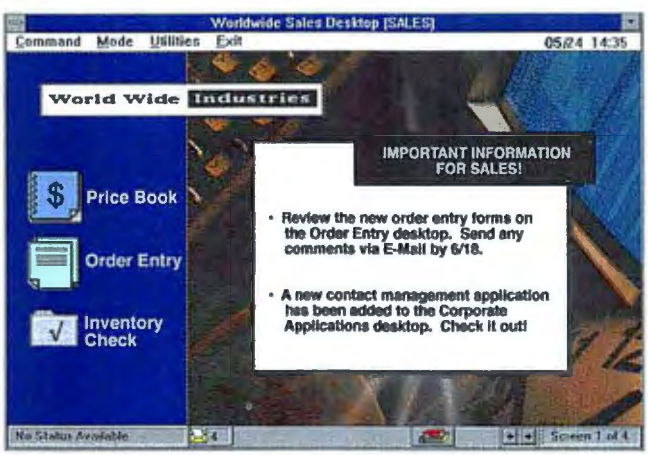
The tasks that give network managers fits at the local site are doubly frustrating when remote users are involved. Software updates, applications auditing, and usage monitoring require different tactics for far-away nodes .

RemoteWare from XcelleNet (Atlanta, GA) is a suite of client/server software tools for creating and managing applications systems that automate information flow between remote/mobile users and central information systems. Besides a server component, the RemoteWare line includes the Forms, Report, Document, Desktop, and Mail modules. Using RemoteWare, a manager can update a form or provide new desktop options to all appropriate remote personnel automatically. Similarly, the remote client can send his or her updates to the server as a mail message, and the RemoteWare server software routes those changes to the appropriate locations. For example, an expense report might go to the accounting department or orders to the warehouse.

You also want to know who does or does not call in during certain periods of time. In a sales application, it is particularly important to monitor reports from the field. RemoteWare and the management components of many remote-access servers keep a log of who calls in and when.

It is also difficult to monitor remote users for authorized software. As a manager, you don't want to support different software for each client or be responsible for pirated software used at a remote site. One way to minimize the problem is to tightly weave the remote applications to the local database, and this frequently happens with legacy applications.

But this method does little to prevent remote clients from using unauthorized nonnetworked tools. RemoteWare provides the means to lock out anyone who attempts access with unauthorized software. One product, SEAM (Saber Enterprise Applications Manager) from Saber Software (Dallas, TX), specializes in this task. SEAM is a Windows/DOS software-metering tool that creates a TSR program that resides on the client system. This TSR monitors the software being used according to predetermined rules. SEAM also lets you share licensed software.



XcelleNet's RemoteWare lets you build forms-based applications using simple icons for access. Updates to both the forms and icons can be sent automatically from a central location.

Keeping Up to Date

In a large organization, there could be hundreds of information transfers between remote clients and the local database occurring at any time. It is impossible to make all the information generated at either end available to everyone immediately. At best, you can make it available in real time when the remote client connects, but this is the most expensive route. Some organizations, especially those that deal with frequent financial transactions, have no choice. "We want to be extremely confident that we don't have cross-tier and cross-timeline discrepancies," says Jeff Devlin, a database manager for The Equitable Companies (New York City).

To perform a real-time update requires the use of intelligent software at both ends of the transaction. This software analyzes the data, routes it to the appropriate storage location, and updates the database. It also checks to see who else is accessing the same data at that time and acts according to a predetermined set of rules that governs who has priority when multiple clients access the same data simultaneously. For example, client A logged in first, so the software notifies client B that the data is unavailable. When client A is finished, the software sends an all-clear message to client B.

Updating in real time also demands that data be treated discretely, rather than as files. That is, if client A places an order for 10 widgets, only the changes to the database are transferred. Sending that data as a file would require getting an entire subset of the database; another step would be needed to analyze the subset and extract the changed information before making the updates.

DataSync from Datawatch Corp. (Research Triangle Park, NC) is a database-synchronization middleware tool that helps you build the necessary intelligence into your software. As you create a DataSync application, the product lets you define data subsets that will be transferred between the remote clients and the local site. You also set up "synch" rules, which tell the application the specific rows and columns in the database to choose from. These rules can be customized.

DataSync relies on ODBC (Open Database Connectivity). ODBC, developed by Microsoft, provides a common interface for Windows applications to access networked databases. Most relevant Windows applications now provide ODBC drivers, including contact managers like Symantec's

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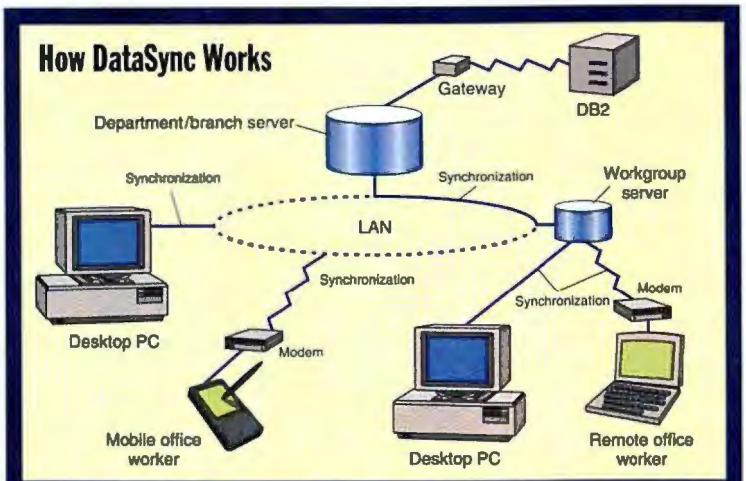
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DataWatch's DataSync relies on ODBC applications to maintain data integrity. Users permanently connected via the desktop access the server to directly modify the data, sending changes only to the server database. Remote users receive via modem a subset of the data, which is then synchronized with the local database.

ACT and database software like Microsoft Access. This permits more flexibility in terms of the applications remote clients use as front ends. For example, if client A wants to use ACT and client B wants to use Lotus Approach, both can be accommodated, assuming that the applications are ODBC-capable. You can also build the applications using Visual Basic or C++. DataSync requires Windows on the client side, but it's platform-independent on the server side.

The more often you dial in, the higher your phone bill. For many businesses, however, frequent updates are not as critical. In these cases, the remote clients can log in once a day, upload their data (usually as a file), and receive their own updates and other messages. At the local site, those files are processed batch style—probably after hours—and the database is updated.

Cost isn't the only reason to process database updates in batches. "Some legacy applications are not meant for remote access," says Mark Freitas, who's vice president of Microcom. Rather than rewrite the application, it is easier to gather the updates and process them independently before changing the data on the legacy system.

The very nature of distributed computing encourages the use of remote nodes. While remote clients complicate the design of distributed networks, ensuring that all users have access to the information they need more than makes up for the trouble. ■

Michael Nadeau is a BYTE senior editor. You can contact him on the Internet or BIX as miken@bix.com.


Cesar Alonso

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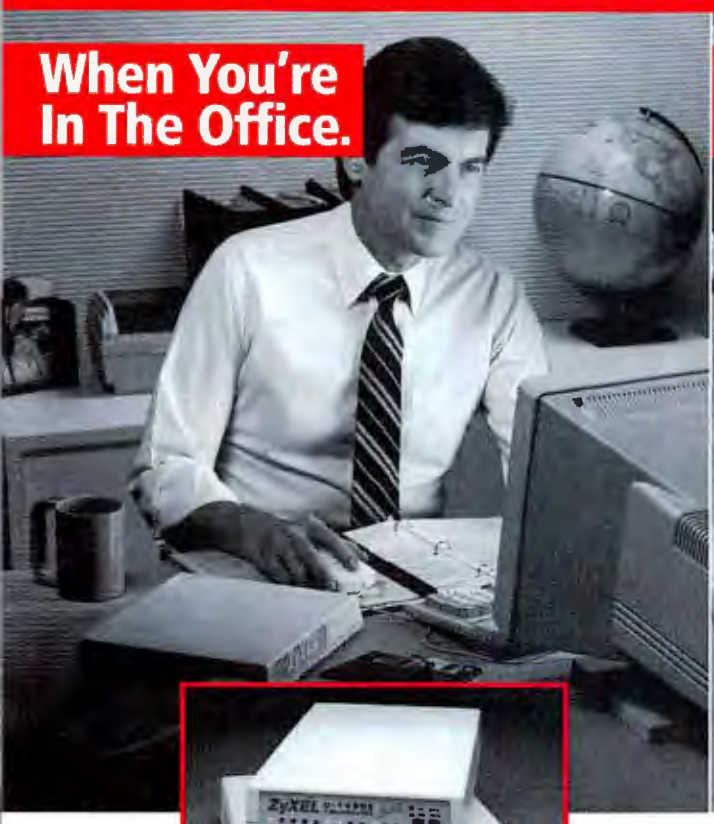
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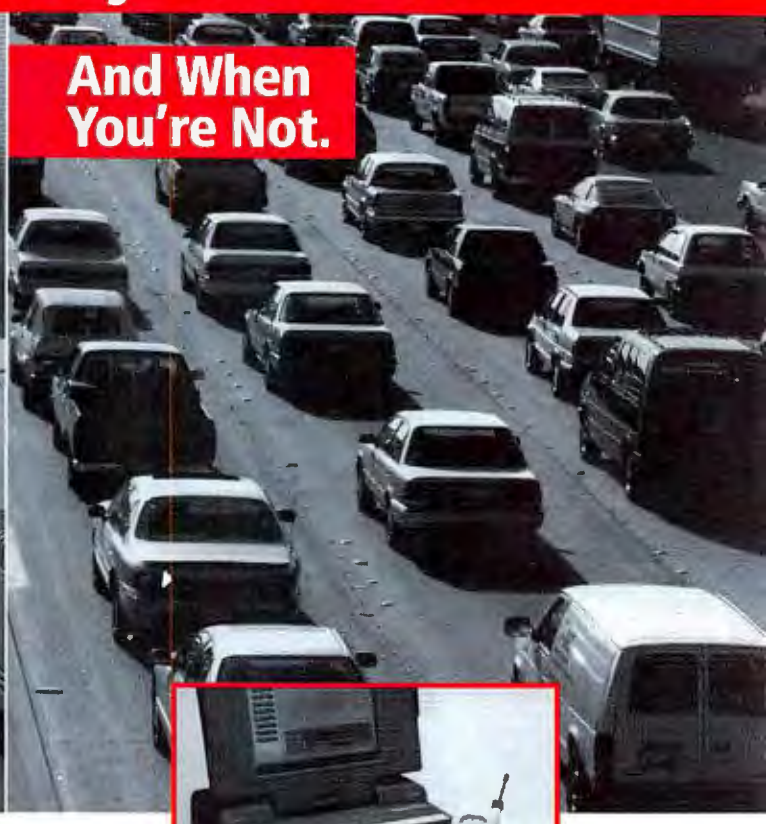
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Power to the New Macs

Power Macs deliver ample performance, with more to come

TOM THOMPSON



Although housed in Centris/Quadra-type cases, the new Power Macs provide RISC performance at affordable prices. From left to right: the 6100/60 with 60-MHz PowerPC 601 CPU, the 7100/66 with 66-MHz CPU, and the 8100/80 with 80-MHz CPU. Prices start at $1819 for the Power Mac 6100/60, with 8 MB of RAM and a 160-MB hard drive but without a monitor or keyboard.

Apple missed the Mac's tenth anniversary by only two months when it introduced its new PowerPC-based computers, the Power Macintoshes, in March. Considering the hurdles the Power Mac design team faced, the schedule slip is forgivable. With the new Macs, the team had to implement the contradictory goals of supporting an existing base of CISC software that has built up over the decade and harnessing the throughput of the PowerPC 601 RISC processor (See "Apple, IBM Bring PowerPC to the Desktop," April BYTE). Not only that, but the new systems had to be affordable as well.

The results are embodied in three machines. The Power Mac 6100/60 system has the lowest price at $1819. (Prices are without monitor and keyboard.) It uses a Centris 610/Quadra 610 pizza-box chassis with a 60-MHz processor, a single 601-specific Processor Direct Slot (PDS) for expansion, and a 160-MB hard drive. An adapter lets the 6100/60 use a 7-inch NuBus board.

The midrange Power Mac 7100/66 inhabits a Centris 650/Quadra 650 chassis and provides a 66-MHz processor, one 601 PDS slot, three NuBus 90 expansion slots that can hold 13-inch boards, and a 250-MB hard drive. This system costs $2899. Finally, there's the ultimate power-user system: the Power Mac 8100/80. Based on the Quadra 800's successful mini-tower design, it has an 80-MHz processor, one 601 PDS slot, three NuBus expansion slots, and a 250-MB hard drive. It costs $4249.

The Power Mac hard disks may seem small compared to those in PC systems, but they're ample for Mac applications, which are typically far smaller than Windows applications. Also, the three systems come standard with 8 MB of RAM, built-in Ethernet, CD-quality (16-bit samples at 44.1 kHz) stereo sound, and on-board video that supports 16- or 24-bit color, depending on the model.

The optional AV Power Mac system configuration is essentially a Power Mac with an Apple AV Technologies board in the 601 PDS. The option also includes an additional 8 MB of RAM for the 6100/60 and 7100/66 systems and an additional 16 MB for the 8100/80. You need the extra memory to support the voice-recognition and telephony software bundled with the AV system.

If you need to run the occasional DOS/Windows application, another Power Mac system configuration bundles Insignia Solutions' SoftWindows emulator. This configuration gives you SoftWindows and 16 MB of RAM. It also jacks up the price $300 to $800, depending on which Power Mac it is.

For owners of Centris 610/Quadra 610, Centris 650/Quadra 650, and Quadra 800/840AV systems, appropriate PowerPC logic-board upgrades are available. For other 68040-based Macs, a 68040 PDS accelerator board with a 601 processor and Power Mac ROMs ($699) will do the trick. Apple has announced that it will also offer Power Mac upgrades for certain 68030-based Macs, but no details were available at press time.

Features and Compatibility

I received all three Power Mac systems for evaluation. Apple equipped each with an optional CD-ROM drive and an AV Technologies board. The Power Mac 6100/60 and 7100/66 came with 16 MB of RAM, and the Power Mac 8100/80 had 24 MB.

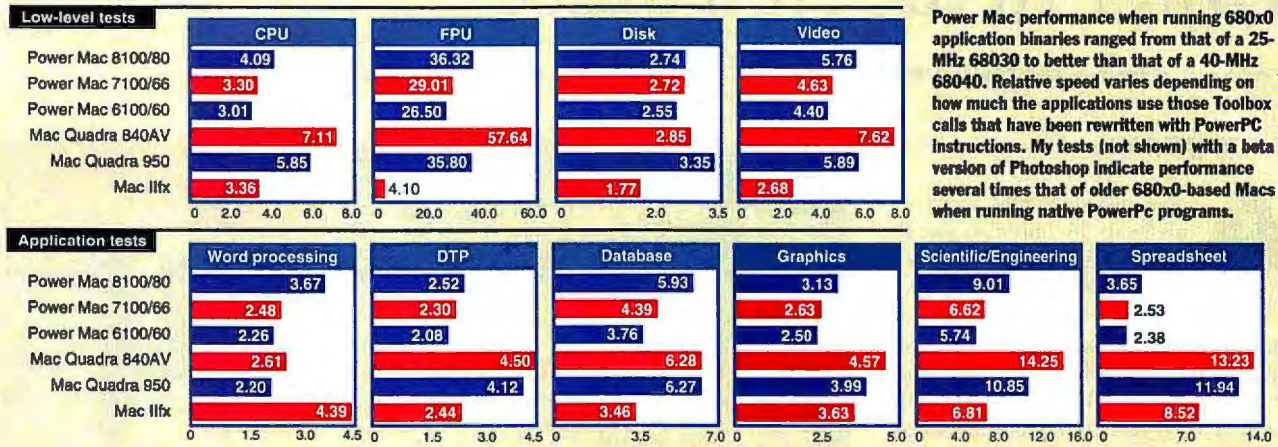
Two features stood out when I used the CD-ROM drive. First, the drive now has a built-in, motorized drawer that holds the disc, rather than that easy-to-lose caddy. Second, the systems readily boot from the CD-ROM drive. Formerly, you had to hold down the Command-Option-Shift-Delete keys to get a Quadra system to boot from its CD-ROM drive; now you just drop a bootable system CD into the drive and tap the power key. This is a handy feature for dealing with emergency disk repairs or installing new system software.

I copied my usual working complement of software to these systems and tried them out for several weeks. Software compatibility was remarkable, considering that all the programs were 680x0 CISC binaries now running on a RISC processor. Applications such as Adobe Illustrator 5.0 and Photoshop 2.5, Microsoft Word 5.1a and Excel 4.0, Claris MacWrite Pro 1.0v4, Aladdin Systems StuffIt Deluxe 3.0.6, and Freesoft White Knight 11.14 worked fine.

Even Control Panels and Extensions that heavily patched the 680x0 trap dispatch table continued to work, such as Adobe Type Manager 3.6, Now Utilities' Super Boomerang 4.0.1p and WYSIWYG Menus 4.0.1, Symantec's Suitcase 2.1.4, and Rock Ridge Enterprises' VideoBeep 1.05. In fact, some applications that run erratically—if at all—on most 68040-based Macs worked just fine on the Power Macs.

The systems' performance makes them naturals for graphics-intensive work. For example, Photoshop 2.5 did lightning edits on large 15- to 20-MB, 24-bit color TIFF files. The biggest performance boosts, however, will be seen in applications rewritten in native code. The question, of course, is how many native applications will appear

Power Mac Emulation Performance



Power Mac performance when running 680x0 application binaries ranged from that of a 25-MHz 68030 to better than that of a 40-MHz 68040. Relative speed varies depending on how much the applications use those Toolbox calls that have been rewritten with PowerPC instructions. My tests (not shown) with a beta version of Photoshop indicate performance several times that of older 680x0-based Macs when running native PowerPc programs.

Results are indexed. For each individual test, a Mac Classic II = 1.0. The Classic II used 512- by 432-pixel screens; other test machines used 640- by 480-pixel screens. For the 68040-based Macs, caches were disabled for the Word Processing tests, and PageMaker 4.2 was used for DTP tests.

on the market in the next few months. I'll get back to that question shortly.

Insignia Solutions' SoftWindows 80x86 emulator ran a number of Windows applications reliably. The emulator doesn't support Windows' 386 enhanced mode, and it requires about 13 MB of RAM—hence the additional memory on the SoftWindows-equipped systems. The emulator mustered performance between that of a fast 386 and that of a 25-MHz 486SX.

Unfortunately, this sort of speed is barely adequate for demanding Windows applications. Running Excel 4.0 in SoftWindows to process some of the Power Mac test results just taxed my patience. If you need to run a Windows application once in a while, SoftWindows will do. But if you expect to use it often, you'll need the patience of Job.

Speed Demons

Benchmark testing showed that the Power Macs' performance when running 680x0 application binaries ranged from that of a 25-MHz 68030 to better than that of a 40-MHz 68040. The spread is wide because not all of the Mac Toolbox code has been written in native PowerPC 601 code yet, so some Toolbox code is actually 680x0 code running in the emulator. Depending on the task, program execution might spend more time in native code—thereby gaining a performance boost—or remain in the emulator for a performance hit.

BYTE's low-level benchmarks support this conclusion. For example, most of QuickDraw has been rewritten as PowerPC code. In the low-level video benchmarks on a Power Mac 8100/80, when a circle fill is done by an algorithm, performance is about that of a Mac IIfx (a 40-MHz 68030). But when QuickDraw is used to fill a circle, performance is as good as on a Quadra 840AV (a 40-MHz 68040). For the screen-intensive word processing application tests, which make heavy use of QuickDraw, the low-end 6100/60 did as well as a Quadra 950 (a 33-MHz 68040), while the high-end 8100/80 bested a Quadra 840AV by a large margin.

The other gotcha is in floating-point performance. Although the 601 is noted for its high-speed floating-point calculations, much existing application software doesn't tap into this capability. Applications that call SANE (Standard Apple Numeric Environment) for floating-point math will see modest performance, since Apple has ported portions of SANE to 601 code. But applications that use only 68881/68882 FPU instructions won't operate at all, because the emulator doesn't support them. These applications either crash or resort to handling the computations in 680x0 code, which bogs down in the emulator.

This situation is also reflected in the benchmark results. In the BYTE low-level floating-point benchmarks on a Power Mac 8100/80, floating-point performance is equal to that of a 25-MHz 68040 when SANE calls are used. You can expect even better performance when 601 FPU instructions are used directly in future applications. However, in the application tests, both Mathcad (which is used for the Scientific/Engineering tests) and Excel rely on the 68881 FPU for fast computations. With no coprocessor, the computations are trapped in the emulator, and performance plummets, skewing downward the overall application index for the Power Macs. Therefore, some particular application indexes are misleading. Judging from my experience, the Power Macs run much faster than these tests indicate.

If you're interested in running a specific category of application on a Power Mac, check the individual benchmark indexes. Remember that the results are only for 680x0 binaries and represent worst-case numbers. Native applications will run much faster: For example, a beta native version of Photoshop was two to four times faster than Photoshop 2.5 running on the same Power Mac.

Like Wine, Over Time

The Photoshop results emphasize an important point: To realize the Power Mac's full potential, native applications are essential. Granted, the emulator is robust and delivers reasonable performance, but it's native application performance that makes the Power Mac shine. A handful of applications were native when the Power Macs shipped in March, with more on the way. (See the table "Native PowerPC Mac

Native PowerPC Mac Applications

Aldus Freehand 4.0
Aldus PageMaker 5.0
Claris Impact 1.0
Claris Works 2.1
Dayna Communications ProFiles 1.0
Fractal Design Painter 2.0
Frame Technologies FrameMaker 4.0.3
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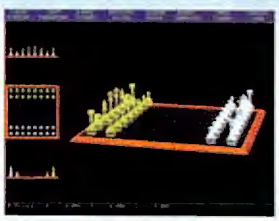
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Applications" for a partial list.)

Adobe takes an ingenious upgrade approach, thanks to the extensibility of Photoshop 2.5. The company provides a free Photoshop plug-in module that replaces most of Photoshop's innards with PowerPC code. Microsoft's Excel and Word programs should be native by the time you read this.

Developing native applications for the new processor isn't as difficult as it appears. Vendors who have already written their program in C or C++ for cross-platform porting will only have to recompile their programs with a PowerPC compiler. The Power Mac's new core system software also promotes rapid application development (see "The Power Mac's Run-Time Architecture," April BYTE). Also, a slew of PowerPC development tools are appearing on the market, such as Apple's own PowerPC C/C++ SDK (Software Development Kit), Symantec's Think C/C++ 7.0 compilers, Metrowerks' CodeWarrior C/C++ compiler, and Jasik Design's The Debugger (a native debugging utility).

The Mac Toolbox code will evolve over time. Currently, Apple has implemented about 15 percent of the Toolbox as native code. This fraction will increase with future releases of the Mac OS, making current Power Macs run even faster. In an era in which faster desktop computers typically supersede older models in six months, the Power Macs will actually counter this trend, growing faster with new software. It's probably one of the best reasons yet to consider owning a Power Mac. ■

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. from Memphis State University. He is an Associate Apple Developer. Contact him on AppleLink as T.THOMPSON, or on the Internet or BIX at tom_thompson@bix.com.

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Scheduling Across the Enterprise

Sophisticated group scheduling—across platforms and across organizations—has arrived on the desktop

BEN SMITH AND HOWARD EGLOWSTEIN

Pulling together a meeting involving a large group of people, especially across different departments and geographic locations, can be extremely tedious and frustrating. If you don't think so, then you probably have someone doing the job for you. Group-scheduling software relieves some of the tedium of corporatewide scheduling by accessing the combined calendars of all the people across an organization. A group scheduler can find a time when all meeting attendees are available, reserve a conference room and audiovisual equipment, notify all attendees of the time and place of the meeting, and update individual calendars automatically. And all this is accomplished by a few simple mouse-clicks.

Even though group schedulers look very much like personal calendar programs, shared access adds an order of complexity to the scheduling process. Group schedulers coordinate events that involve people and resources throughout the entire enterprise, so the communications requirements of group schedulers are similar to those of enterprise-wide mail systems. Group schedulers must share meeting-request messages and information about each individual's schedule without invading people's privacy.

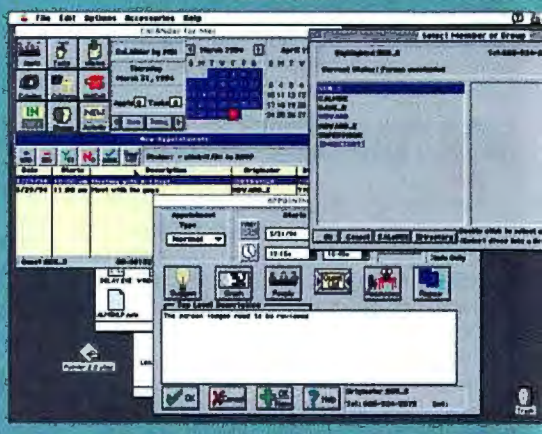
Enterprise-Wide Scheduling

All the group schedulers we review here let you view your schedule by the day, week, and month. You can also maintain a personal to-do list, as well as send and receive messages. Most important, these packages let you negotiate and coordinate meetings with your coworkers and clients. In addition to tracking meeting attendees, these group schedulers reserve and track resources such as a meeting room and an overhead projector.

We looked only at group schedulers that had Macintosh and Windows clients available at the time of our evaluation. Some products, including PowerCore International's popular Network Scheduler, were preparing Macintosh clients but were unable to ship us software in time for this review. We evaluated each of these packages for cross-platform and enterprise-wide support, ease of installation and use, feature set, and management functions.

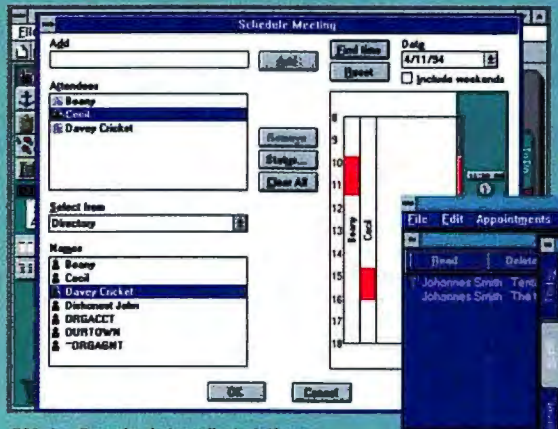
The group schedulers share some key features (see the text box "What to Look For in an Enterprise-Wide Group Scheduler" and the features table on page 220), but these features are enabled by different mechanisms. There are two basic group-scheduler architectures. One type keeps all calendar information on the network server. Local systems access the calendar on the network, make additions and changes, and then save the updated calendar back out to the server. With a true client/server architecture, such as Calendar Manager's, the server coordinates scheduling queries to the shared database and minimizes network traffic. The second type, a distributed group scheduler, uses E-mail to pass scheduling information among individual calendars. In some cases, a group scheduler will use E-mail messaging for sending meeting requests and updating user lists while also sharing user calendars across the network.

CaLANdar



CaLANdar's strong suit is the ease with which it lets you view and report the combined schedules of a group. CaLANdar works well for one person managing the combined schedules of a department or workgroup.

Organizer



Of Lotus Organizer's two client platforms (Mac and Windows), the Windows client takes better advantage of the address book/organizer metaphor and drag-and-drop operation. The main window shows an open notebook with sections for a calendar, to-do list, address book, notepad, and planner.

Schedule+



Microsoft Schedule+ is easy to learn and use, but there are considerable differences in the user interface across platforms. The Mac and DOS client software is less functional; for instance, a to-do list is included only on the Windows client.

Lotus Organizer

You can install Lotus Organizer either as a stand-alone personal scheduler or on a network as a group-scheduling package. In a stand-alone configuration, your schedule is maintained on your local hard drive. The group-scheduling installation puts a schedule for each registered user into a directory on a shared server. When you access your calendar across the network, you have to schlep the data across the network. Lotus Organizer is not a client/server application, but rather relies on this shared file access for communication between users.

Well, sort of. When you invite someone to a meeting, your copy of Organizer accesses the invitee's calendar to see if he or she is available. If so, it takes the meeting information and sends it via cc:Mail to the invitee (cc:Mail is required to install Organizer as a group scheduler). It's a curious blend of an E-mail-enabled application and shared file access.

Why cc:Mail? In Organizer, cc:Mail is the transport layer that takes care of notifying users across large networks (or multiple networks). While you can't precheck the schedule for people on another file server, you can include them in your meetings and get notification from them of any meetings you've been invited to.

To facilitate the propagation of multiple messages (when scheduling a large meeting), Organizer uses an agent to handle the message traffic. Perhaps the easiest way to explain the agent is through an example.

Say you want to schedule a meeting with John (who also has a cc:Mail mailbox and schedule on your server) and Marsha (whose mailbox and schedule reside on another server in another office). When you bring up your schedule and create a new meeting, both John and Marsha appear in your directory. Marsha is flagged as a remote cc:Mail user. Your schedule shows no conflict with John's, and it is unable to check Marsha's, so you schedule the meeting. Organizer marks your schedule and then generates messages for John and Marsha.

The Organizer agent runs on a dedicated PC or as a scheduled task on a cc:Mail router and picks up the messages. It then generates a local message to John and a remote message to Marsha. The cc:Mail router picks up Marsha's message and sends it out to Marsha's network.

John reads his mail and finds out that you've called a meeting. He launches the file enclosure, which brings up Organizer and asks him to accept or decline the meeting. When he accepts your meeting, a message shoots back through the agent and alerts you. Marsha's message is handled similarly, except that it has to go through agents and routers on both servers. Depending on how the agents and routers are set up, it could take minutes or hours for a message to make it all the way through the notification process.

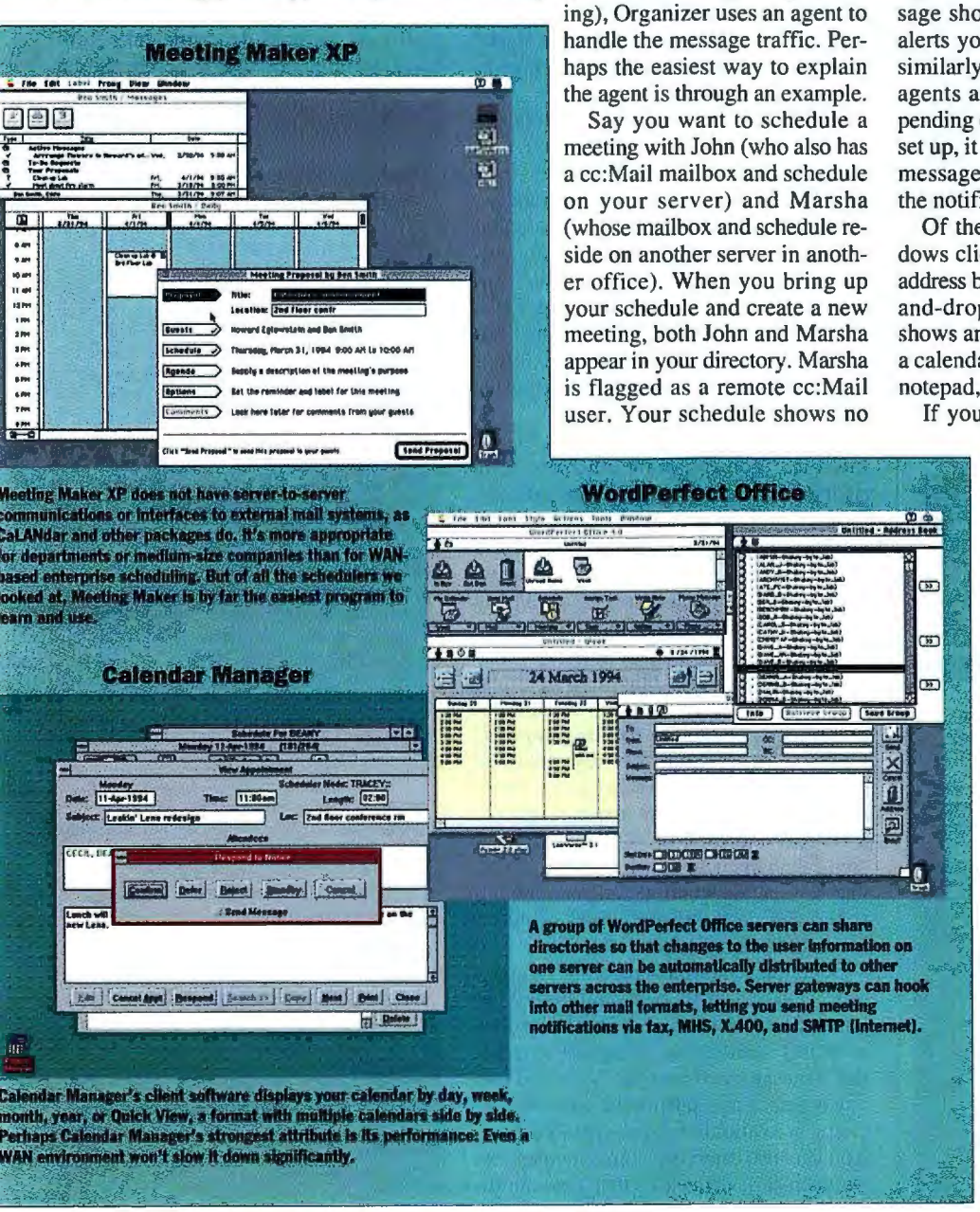
Of the two client platforms, the Windows client takes better advantage of the address book/organizer metaphor and drag-and-drop operation. The main window shows an open notebook with sections for a calendar, a to-do list, an address book, a notepad, and a planner.

If you haven't seen Organizer in any previous version, you're missing out on one of its best features—links. When planning a meeting, you can link the meeting to the address-book entries for any non-company folks who will be in attendance and further link the meeting to a notepad entry that has a meeting outline. The links feature is extremely convenient and makes Organizer worth looking at as a PIM (personal information manager).

Thanks to a connectivity solution from IntelliLink (1 Tam Blvd., Nashua, NH 03062, (603) 888-0666), Organizer can share its data with a host of popular PDAs (personal digital assistants). IntelliLink also works with Schedule+ and CaLANdar.

Enterprises running a mail system other than cc:Mail wouldn't want to install cc:Mail just to enable Organizer for group scheduling. But if you're already using cc:Mail, Organizer has an excellent user interface and an impressive feature set.

continued

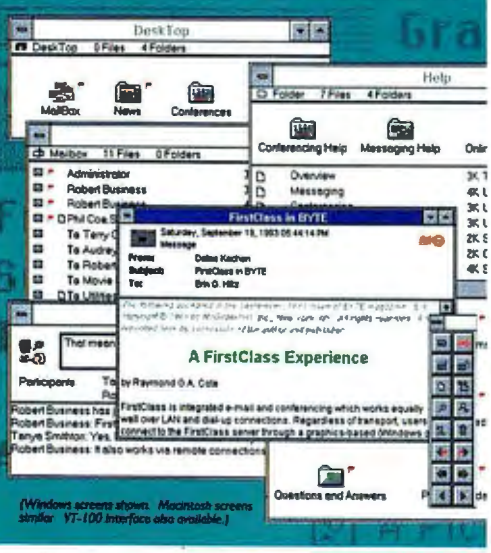


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(Windows screens shown. Macintosh screens similar. VT-100 interface also available.)

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Microsoft Schedule+

Schedule+ requires Microsoft Mail (or Hewlett-Packard OpenMail). If you have already installed Microsoft Mail in your enterprise, it's a snap to add this package to your servers, but Schedule+ does not come bundled with the E-mail system.

Schedule+ shares a number of services with Microsoft Mail: address books and the underlying name service; authorization services (including a single sign-in interface); a message-store database; and message sending, receiving, and retrieval. These services are available through API calls to common DLLs. Programmers can develop customized applications by accessing Schedule+ calendars. Not only do these shared services make Schedule+ easier to use for those familiar with Mail, but shared functions also reduce storage requirements and ease administration chores.

Schedule+ exchanges meeting requests among its clients. When you receive a request, you can accept or decline the invitation. After accepting a meeting request, you then update your personal calendar manually; Schedule+ does not automatically log the meeting into your calendar. Microsoft claims that manual updates give users more control over their personal calendars, but it would be more flexible if you were at least given the option to enable automatic calendar updates.

Schedule+ supports a wide range of permissions. You can grant other users the right to view or even modify your calendar. You can refuse access to your calendar and only allow meeting requests to be sent to you. Or, if a coworker attempts to set up a meeting time, you can issue free/busy packets to let him or her know if you are available at the scheduled time.

You can also give other users permission to read your calendar, create new appointments, or modify existing appointments. The assistant privilege lets you establish proxies. For instance, everyone in a department might grant assistant rights to a central coordinator. The coordinator could then open up multiple users' calendars in separate windows, add and modify schedules, and issue meeting requests around the department.

Schedule+ can pass meeting requests or free/busy packets across multiple Mail post offices, providing a WAN (wide-area network) solution for enterprise scheduling. You can reach over the WAN and find out whether any corporate coworker or client is available for a scheduled time. You can also establish a direct connection between post offices so that you can directly access other users' schedules across the enterprise.

This same structure effectively supports remote users, too. You can dial in and simply receive any meeting requests issued to you, or you can log in to the network and reconcile the schedule you've been keeping on the road with any additions or updates made to your home schedule.

This architecture works well on a single platform. Windows clients can share the calendars of other Windows clients and pass free/busy packets around, and Mac clients can do the same. The problem comes when you try to mix the two environments. Schedule+ supports only the passing of simple meeting requests across platforms. You can't share calendars across platforms, so your departmental coordinator would not be able to access the cal-

What to Look For in an Enterprise-Wide Group Scheduler

Dial-in users. This feature lets you dial into the group scheduler to update and receive calendar data.

E-mail support. If you already have E-mail in place, look for a group scheduler that supports your flavor of mail or go with a scheduler with built-in messaging. You probably don't want to install a second full-fledged mail system to enable group scheduling.

Find free time. Automatically finds a time when all attendees and resources are available for a meeting.

Wide-area connections. Allows multiple calendar databases to share scheduling information across servers. You'll need this capability to enable enterprise-wide scheduling across a WAN (wide-area network).

Notify nonusers. Sends mail to notify meeting attendees who are not licensed to use the scheduling application. Some schedules can even notify nonusers via fax.

Off-line users. Allows you to schedule appointments even when you are not attached to a network. **Synchronization** capabilities ensure that all your appointments are reconciled to a single calendar when you log back on to the network.

Platform support. Make sure the group scheduler operates on all the platforms used in your organization. In a large mixed environment, a consistent interface across platforms can make user training and support much easier.

Proxy. Grants another person access to your calendar. You need this capability if you have a central coordinator or an assistant who tracks your appointments.

endars of both Windows and Mac users from a single workstation. In fact, you can't even pass free/busy packets across platforms, so Mac clients can't search Windows clients for open meeting times, and vice versa.

Schedule+ is easy to learn and use, but there are considerable differences in the user interface across platforms. The Mac client software appears to be several revisions behind the Windows version, and it lacks some of the functionality, as does the MS-DOS version. (The DOS client is supplied by PowerCore International.) For instance, a to-do list is included only on the Windows client.

The scheduler itself lacks some niceties. Scheduled meetings must begin and end on 15-minute intervals (i.e., 1:00, 1:15, 1:30, and so on), and the allocation bar does not inform you of the meeting scheduled unless you double-click on it. For installations already using Mail, Schedule+ is a simple upgrade and offers an enterprise-wide solution—if you can accept the cross-platform limitations.

Microsystems Software CaLANdar

Rich with features, the CaLANdar Enterprise Scheduling system is designed for the eclectic user of electronic communications. Besides the standard tools for group scheduling, CaLANdar maintains a fairly extensive database file (Calodex) on each person that has a CaLANdar account and an automatic phone dialer. (It is not clear how to set up the dialer, however.) There is a network chat utility for communicating with another user, as well as a handy In/Out status indicator. CaLANdar can import and export to other file types and communicate with the appointment manager on the Sharp Wizard.

CaLANdar's strongest suit is the ease with which it lets you view and report the combined schedules of a group. CaLANdar works well for a person who must manage the combined schedules of a department or workgroup. A single person can (with permission) access other people's schedules, one at a time. Unfortunately, the group detail report can only be printed; it is not one of the screen displays.

Installing CaLANdar is somewhat difficult; however, the program will support a complex organization. It can communicate with other CaLANdar servers via an external E-mail system. The E-mail gateways include cc:Mail, Microsoft Mail, Vines Intelligent Messaging, Da Vinci eMail, BeyondMail, WordPerfect Office, and any MHS-based E-mail system.

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ANGOSS Software
The Shape of Things to Come

The Macintosh and Windows user interfaces are very similar. CaLANdar has a unique time-bar display for navigating your daily schedule, and a clever link between the windows of different displays. There is even a fair amount of consistency in the MS-DOS interface, despite its heavily layered, multilevel menu approach. (Unfortunately, the MS-DOS version requires a huge amount of memory and will not load if you have a rich set of TSR programs and device drivers on your system.) Each user interface has context-sensitive help.

CaLANdar requires a PC-network server. Mac clients must mount the server through the Chooser. This makes for slow database access on the Macs.

On Technology Meeting Maker XP

Meeting Maker XP was the easiest program to install. The server can reside on either a Mac or a PC, but Meeting Maker does not have server-to-server communications or interfaces to external mail systems, as do CaLANdar and others. This system is more appropriate for departments or medium-size companies than for WAN-based enterprise scheduling.

Meeting Maker can import and export user lists through intermediate text files. This can make installing new servers easier. The message database is proprietary. It was fast and easy to maintain, even when we used a Mac SE as the server.

The Mac server talked to PCs through an IPX network stack for the Mac, which comes with the product. Only the server required the IPX stack, so that it could talk with the client PCs. The other Macs were already using AppleTalk, so no additional protocols were needed on the Macintosh side.

Meeting Maker lets you open a separate window (or iconized window) for any number of coworker schedules, as long as those people have given you permission to be a proxy for setting up meetings. As you attempt to include people in a meeting, you are warned of possible conflicts. You can also call a graph of the group schedule, which shows when other invited participants have scheduled activities. These tools would help a central coordinator devise departmental schedules. Unfortunately, the graph does not give you more than a day's view, so it's only good for picking a time within a day, not for determining the best day to hold the meeting.

Meeting Maker has the easiest find-free-time facility of any of the group schedulers. Click on a single button, and Meeting Maker suggests the first time and day that the invited members can get together without a conflict. Subsequent clicks generate other suggestions. The other group schedulers do this as well, but none as intuitively as Meeting Maker.

Meeting Maker retains the native look and feel of the Mac and Windows platforms. You can work off-line, so you don't have to maintain an active network connection to use your calendar.

Meeting Maker lacks the complexities necessary for distributed group scheduling, but of all the schedulers we reviewed, Meeting Maker is by far the easiest to learn and use.

Russell Information Sciences Calendar Manager

Of the reviewed products, Calendar Manager is the only one that strictly implements the client/server model in the manner most people would expect. The server in Calendar Manager runs as a background task on a network file server. Depending on your environment, the server could be a NetWare 3.x server or a DEC VAX running VMS and DECnet. For mixed environments, all the server options can also communicate via TCP/IP protocols. Although Meeting Maker's use of a dedicated workstation as a server would also classify it as a client/server environment, that solution ties up a workstation. Calendar Manager uses leftover processing power on your file servers to manage the scheduling database.

The wide variety of servers supported by Calendar Manager suggests an equally rich selection of clients; we tested only the Windows and Mac client software, but Calendar Manager clients also run over DOS and Teamlinks/Pathworks for VMS. Older computer installations that still have ASCII terminals attached to a minicomputer can use the terminal client software ($2200 to $30,000 for an unlimited license, depending on system CPU configuration). Our test server was a VAXstation running

	LOTUS ORGANIZER	MICROSOFT SCHEDULE+	MICROSYSTEMS SOFTWARE CALANDAR	ON TECHNOLOGY MEETING MAKER XP	RUSSELL INFORMATION SCIENCES CALENDAR MANAGER	WORDPERFECT OFFICE
Price per seat[1]						
10 seats	$116	$79	$59.50 single platform; $69.50 DOS, Win, and Mac	$79	$178 per client[2] + $995 for first server	$90 per client + $295 per server
1000 seats	$33	$49	$30 single platform; $40 DOS, Win, and Mac	$57	$58	$70
Architecture	Distributed database	Distributed database	Shared database	Distributed database	Shared database	Shared database
E-mail interface	ccMail required	Microsoft Mail or Hewlett-Packard OpenMail required	Many (none required)	None required	None required	Included (primary function)
Find free time	●	●	●	●	●	●
DOS client	In July	●	●	●	●	●
Wide-area connections	●	●	●	○	●	●
Notify nonusers	●	●	●	○	●	Mail, fax, printer
Proxy	●	●	●	●	●	●
Dial-in users	○	●	●	○	○	●
Off-line users	●	●	●	●	●	●
Synchronization	○	●	●	●	○	●
Import/export calendar database	●	●	●	●	○	●
Import/export user list	●	●	●	●	●	●
Import/export formats	ASCII, IntelliLink option for HP 95LX, HP 100LX, OmniBook 300, Casio B.O.S.S., Tandy Z-550 Zoomer, Sharp Wizard	ASCII, IntelliLink option for HP 95LX, HP 100LX, OmniBook 300, Casio B.O.S.S., Tandy Z-550 Zoomer, Sharp Wizard	ASCII, IntelliLink option for HP 95LX, HP 100LX, OmniBook 300, Casio B.O.S.S., Tandy Z-550 Zoomer, Sharp Wizard	ASCII, Casiolink, HP-100LX, HP 95LX, Newton, Sharp Wizard	ASCII	ASCII

[1] Price per seat for 10-user bundles and 1000-user bundles. Other volume discounts are available. Prices for large volumes are usually negotiable.
[2] Smallest available quantity is 20 seats.

● = yes; ○ = no.


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VMS and using DECnet to communicate with our Macintosh and PC/Windows clients.

Calendar Manager's interface is remarkably similar across the Mac and Windows clients. In a large mixed environment, a consistent interface can make user training and support much easier.

Calendar Manager's client software displays your calendar by day, week, month, year, or Quick View, a format with multiple calendars side by side. In most organizations, busy executives will want to have an assistant check or update their calendar in their absence. For example, the VP of R&D in your company might choose to give her secretary full access to her schedule but keep her secretary from seeing the detailed agenda for some of the meetings. The office manager may need to be able to check the schedule without making changes. Calendar Manager's access modes make configuring these proxy levels a breeze. When you access someone's schedule as a proxy, the window is clearly marked to avoid confusion.

Resources (e.g., overhead projectors and conference rooms) are "invited" to a meeting in approximately the same way as users. One incredibly useful addition is the wild-card support in resource names. If your company has several conference rooms on each floor, you might designate them as #CONF_1A and #CONF_1B on the first floor and #CONF_2A, #CONF_2B, and #CONF_2C on the second floor. When you schedule a meeting, you can designate #CONF_2B if you want that specific room, #CONF_2* if you'll take any room on the second floor, and #CONF_* if you'll take any room on either floor. Using the star convention is pretty universal across Calendar Manager's client base and is an effective way to deal with groups of similar resources.

Perhaps Calendar Manager's strongest attribute is its performance. Since you have a client/server environment, your instance of Calendar Manager will send its request rapidly to the server using a peer-to-peer protocol (IPX, DECnet, or TCP/IP). The server maintains the calendars for all users registered on that node, performs the scheduling functions on local disk storage, and reports back instantly. Even a WAN environment won't slow it down significantly; DEC uses Calendar Manager across its WAN to coordinate meetings with folks across multiple continents. Using high-speed T1 and similar links, the Calendar Manager servers can speak with each other and come back with schedule confirmations within seconds.

WordPerfect Office

WordPerfect Office's group-scheduling capability can easily be lost in the product's other facilities. It is, after all, primarily an E-mail system. But it does do cross-platform scheduling along with its cross-platform E-mail, and it supports Mac, Windows, and MS-DOS clients. WordPerfect Office can import the full naming conventions of the NetWare name bindery.

The WordPerfect Office server software (i.e., post office) must reside on a PC-LAN server, and so, as with CaLANdar, its database must be mounted on Macs through the AppleShare Chooser. Not only is the performance with this extra networking load slow on the Mac, it is also slow on a 50-MHz 486 running Windows with 8 MB of RAM. It requires a huge amount of disk space on the server—nearly 50 MB.

WordPerfect Office is entirely E-mail-based: Every communication within WordPerfect Office is a mail message that is sent from one user to another or to a group of users. For instance, when you want to schedule a meeting with a coworker, you send an E-mail message to the coworker, who then responds with an E-mail message back to you.

WordPerfect Office provides a form to search for available meeting times. After filling out the form, you are presented with a chart of the scheduled times for the proposed attendees. You can also designate a proxy to maintain your schedule.

Unfortunately, the user interface is far from intuitive unless you just want to use the scheduler as a simple adjunct to WordPerfect Office E-mail. And, as with Schedule+, the schedule and event granularity is limited to 15-minute intervals.

The WordPerfect Office scheduler has an impressive collection of formats in which to view your schedules. A group of WordPerfect Office servers can share directories, so changes to the user information on one server can be automatically distributed to other servers across the enterprise. Server gateways can hook into other mail formats, letting you send meeting notifications via fax, MHS, X.400, and SMTP (Internet). It is an attractive option if you are establishing an enterprise-wide E-mail solution and consider group scheduling a secondary concern. But dedicated group schedulers are less complex to set up and use.

A Schedule to Keep

Microsoft Schedule+, WordPerfect Office, and Lotus Organizer each run on the vendor's own established E-mail system. If you already have the underlying E-mail transport installed across the enterprise, the associated schedulers are an appropriate choice. Lotus Organizer has one of the best interfaces around, and Schedule+ includes strong support for WAN connections and dial-in users. Both products lack cross-platform consistency.

For large enterprises with WAN connections, Calendar Manager delivers the most effective solution. Its client/server architecture provides robust performance and seamless cross-platform support over LANs and WANs.

For smaller workgroups with Windows and Mac clients, Meeting Maker XP is by far the easiest package to install, learn, and use. It's an excellent choice for any workgroup that does not include WANs. ■

Ben Smith and Howard Eglowstein are testing editors for the BYTE Lab. You can contact Ben on the Internet at ben@bytepb.byte.com or on BIX as "bensmith." You can reach Howard on the Internet or BIX at heglowstein@bix.com.

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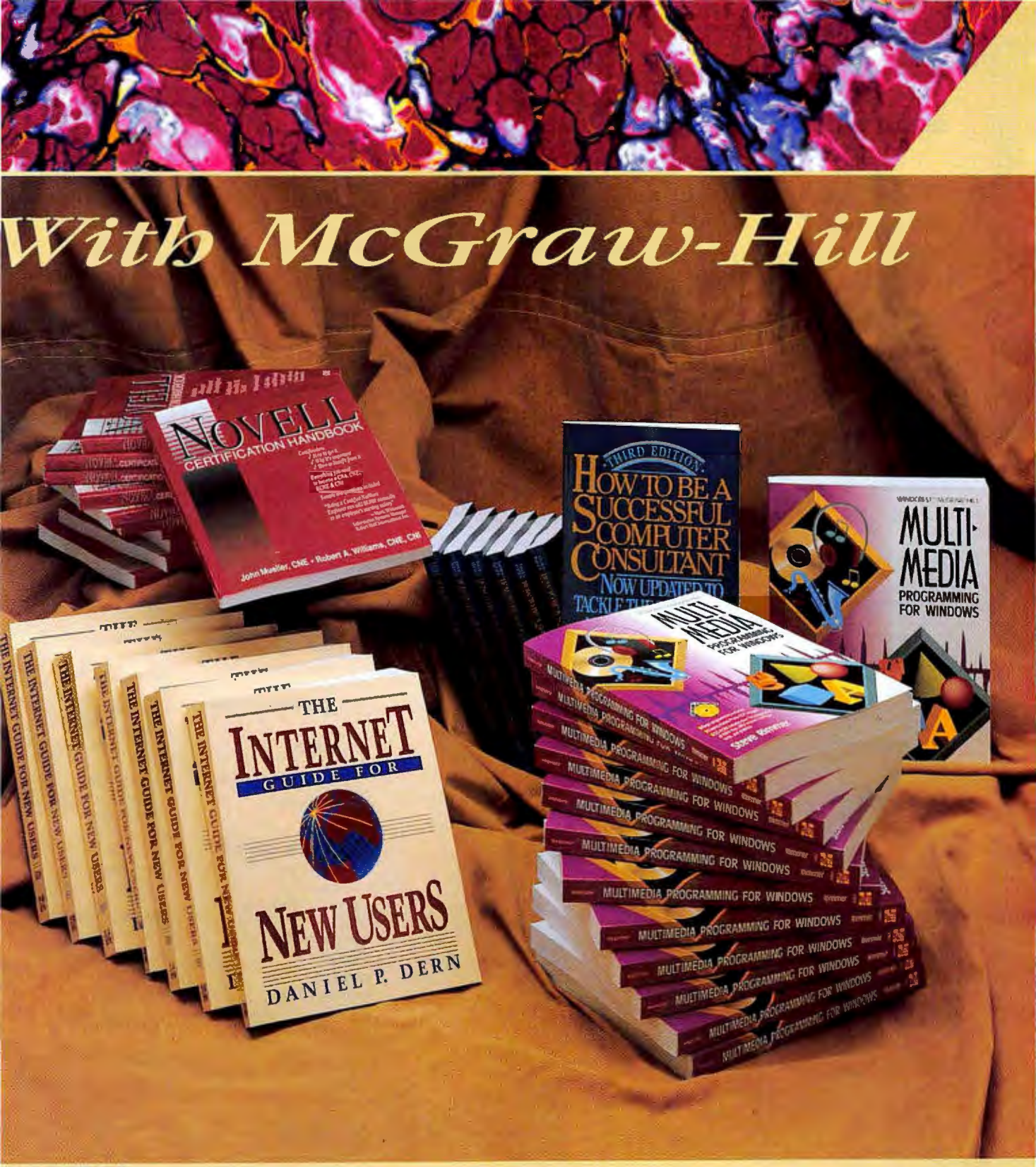
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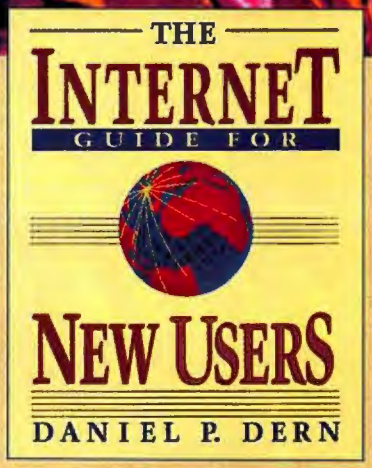
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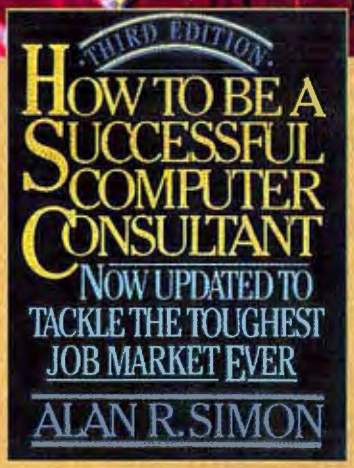


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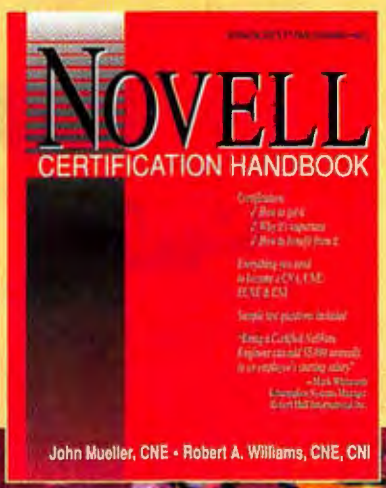
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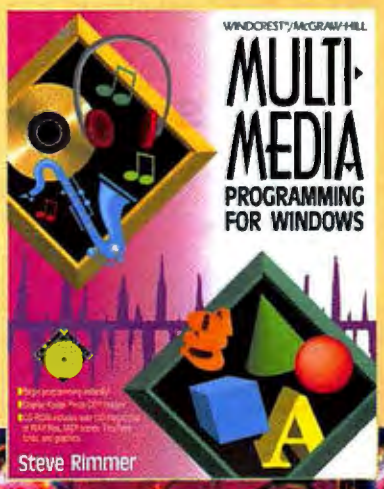
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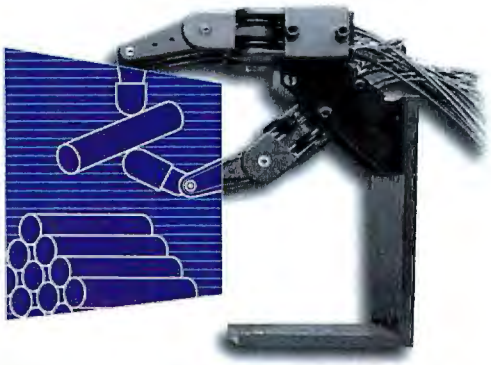


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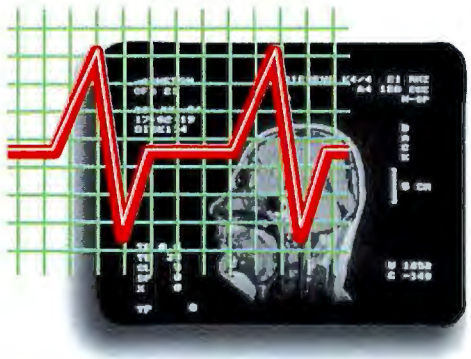
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Plug-and-Go File Server

A dedicated NFS server with appliance-like ease of use, the FAServer provides affordable performance and data reliability

BRUCE DAWSON

True to its name, Network Appliance Corp. (NAC) makes a file server that you basically just plug in and use. Attach a few cables, answer a few installation prompts, and the FAServer 400 is up and running, providing up to 27.3 GB of fast, reliable Level 4 RAID storage.

The FAServer is a dedicated file server for LANs with clients supporting NFS (Network File System) protocol—typically Unix sites running TCP/IP as an Ethernet protocol. However, the FAServer isn't just for Unix environments; many multiprotocol networks support TCP/IP, often with NFS support for clients other than Unix machines.

As an NFS server appliance, NAC's FAServer can specialize in file serving and provide better performance, reliability, and economy than the general-purpose Unix workstations typically used as NFS servers. With its proprietary file system, tuned to function with both the NFS protocol and RAID 4, the FAServer provides both exceptional performance and such niceties as automatic on-disk incremental backups, hot swapping, and incremental capacity growth. Using a dedicated file server also simplifies administrative tasks, such as backups and account administration, and relieves workstations of the burden of serving files.

Starting at $16,995 for a unit with two mirrored 1-GB hard drives and 16 MB of RAM, the FAServer 400 is actually part of a small product line. At the upper end is the rack-mounted FAServer 1400, which supports redundant power supplies and goes for $20,995 with two 1-GB drives.

What's NFS?

NFS is a network-file-server protocol developed by Sun Microsystems. It layers on top of IP, which runs over a wide variety of media (most typically Ethernet, but serial lines, FDDI [Fiber Distributed Data Interface], and wireless LANs are not uncommon).

NFS is a *stateless* file-sharing protocol, which means that the file server can reboot and its clients won't notice, except for the delay during the reboot. Hence, it is an ideal protocol to run over large networks that have long latency delays or that cover a wide geographical area, such as the Internet.



Inside the FAServer 400's big black case is room for up to seven 1- or 2-GB SCSI-2 hard drives. Because of NAC's WAFL file system, you can add drives to the RAID-4 array one at a time.

While NFS is a de facto standard in the Unix world and many Unix systems support it, NFS has not caught on in the PC marketplace. One reason for this is that it requires additional protocols to manage the technical details of such server application necessities as file and record locking and file system mounting and unmounting. These capabilities were designed to run as processes separate from NFS, and that's something DOS doesn't handle as gracefully as Unix does.

However, a number of companies have warmed to the capabilities of Unix, especially for large applications, and have invested in Unix systems. Companies that want to share data among all their computers—which often include PCs, Macintoshes, and Unix and other systems—can choose from a good selection of TCP/IP software that often includes NFS support as an option.

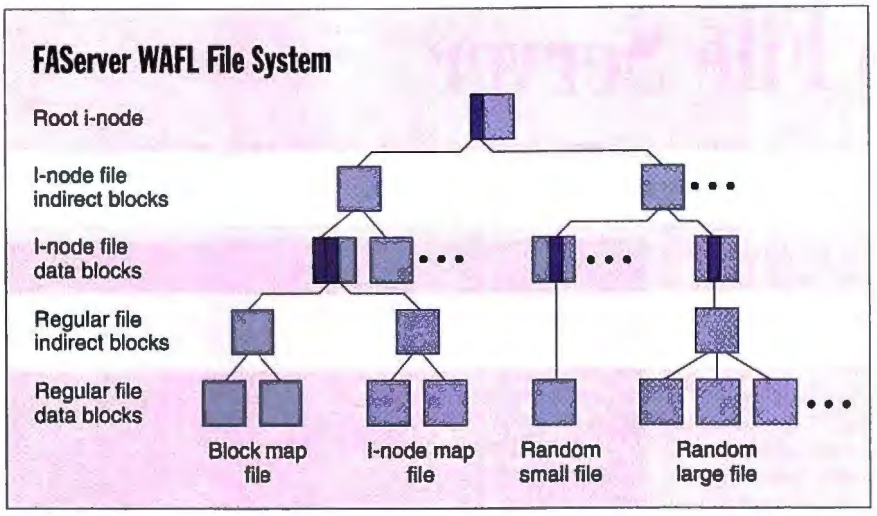
Not Unix

If you have the idea that the FAServer runs Unix and that you can therefore do things like add additional commands, get ready for a surprise. It's not Unix, or even close to it. The FASware operating system is an embedded system with precious few Unix-like commands—only the bare necessities for administering the system. If it used Unix or a Unix derivative, the FAServer wouldn't be able to provide the performance that it does because of overhead.

Not only does the operating system lack many Unix commands (those it does have are similar to their Unix counterparts), the file system is radically different. NAC named it Write Anywhere File Layout (WAFL for short), because any part of the file system, including the file management information, can be written anywhere on a disk. Partly as a result, the FAServer gets around the performance bottleneck that RAID-4 designs typically create because they must update a dedicated parity drive with every write operation.

RAID offers the advantages of data protection through redundancy (the parity drive), a large data space through ganged drives, and high performance through parallel access to multiple drives (known as *striping*). The technology used to implement the various RAID levels becomes more sophisticated as the level number increases.

RAID 5 is currently the most sophisticated because it stores parity information on all the drives, making the parity updates less of a bottleneck. It also has the disadvantage of requiring that you add



The FAServer makes the most of its RAID-4 drive system by collecting and organizing write operations for periodic disk updates. NAC's WAFL adds to this efficiency; all updated data blocks, as well as changes to directory and allocation information, are written in roughly the same stripe across the drive array. Files are located using arrays of pointers called *i-nodes*. The *root i-node*, the only block with a fixed location, describes the file system and points to the i-node file, which in turn points to file blocks, including the *block map file* that tracks disk allocation and the *i-node map file* that tracks free i-nodes. One or more layers of indirect pointers are used for larger files (as shown). A snapshot is simply a copy of the root i-node taken at a particular time. Because old data and directory information aren't overwritten immediately, a snapshot can recover old versions of files.

disks in increments of whole arrays (instead of single disks).

NAC chose to use RAID 4, which has most of the features of RAID 5 but lets you augment the array incrementally with single disks. (The FAServer operating system supports this.) In addition, NAC's WAFL file system overcomes the performance disadvantage of a dedicated parity drive.

With its WAFL system, the FAServer doesn't overwrite an existing file to update it; it writes the update to a new area and then changes internal pointers to the file. Such updates include any directory and block allocation data that changes, too. The FAServer holds incoming write data and NFS requests in its battery-backed 2-MB cache (upgradable to 4 MB) so that it can organize all new writes and updates into an efficient, all-in-one write operation that occurs in a narrow band across all drives, including parity updates.

WAFL writing episodes occur every 10 seconds or so and are managed so that a dirty server shutdown, such as from loss of power, won't corrupt any data—even that in the battery-backed cache RAM.

Backup Reliability

The WAFL file system has reliability benefits as well. Because old data isn't overwritten immediately, it still exists on the drives. And just as the FAServer maintains the file data, it also maintains the pointers to that data, so all the data on the drive as it existed at a particular time is recoverable. NAC calls this concept *snapshots*.

Essentially, a snapshot is a read-only version of the entire file system at a particular point in time. The FAServer maintains up to eight snapshots of the file system that users can access to recover files as long as two weeks after deletion.

A frequent problem with making backups of a running system is that some data will change while a backup is under way. This problem isn't specific to file servers, but is common to all multiprocessing systems. Usually, you should first bring such a system to stand-alone mode so that there is no activity other than the backup.

Because of the FAServer's WAFL file system and snapshots, however, you don't have to bring the server down for backups. When it comes time to back up the server, all you have to do is back up the snapshot files, and file system consistency will be preserved. This one feature could easily justify the procurement of a FAServer to organizations that want highly available systems.

Of course, this snapshot method is a bit more complex than the traditional file-writing method, so NAC has provided several commands to help in snapshot management. The Administration Guide has also done a good job describing the basic principles behind the snapshot method. The snapshot management commands allow the administrator to reserve space for snapshots, create and delete them, rename them, schedule them, and list them. Snapshots are client accessible (as read-only subdirectories of the mount-point directory), and the administrator can choose to disable snapshots entirely or schedule them as often or as seldom as desired.

Room to Grow

The FAServer 400 has a 50-MHz 486 CPU, an Ethernet board (with thick and twisted-pair Ethernet connections), a small VGA monitor and graphics card, and a 3½-inch floppy drive for loading software. I tested the $16,995 base unit with 16 MB of RAM (expandable to 128 MB) and two 1.08-GB Fujitsu hard drives. Since RAID-4 uses one disk for parity, that leaves 1.08 GB of actual storage.

It's a rather large, wide black tower on casters, with room for up to seven hard drives. An additional chassis ($2995) can hold seven more. Drive capacity can be either 1.08 or 2.1 GB; maximum capacity is 27.3 GB, which appears as a single volume. The unit has four fans, which in older units can be quite noisy. The FAServer I tested had older fans and produced a sound reminiscent of a space heater. I moved it to the computer room because of all the noise.

For an appliance, the FAServer has a surprising number of expansion options. In its EISA expansion slots it can take up to four network adapters, including one or two FDDI adapters and up to two SCSI-2 controllers.

After I completed the review of the 400, NAC started replacing this model with its new 450 (for the same price). The 450 has a slightly larger case that can hold 14 drives instead of seven. All else, including the electronics and software, remains the same as in the 400.

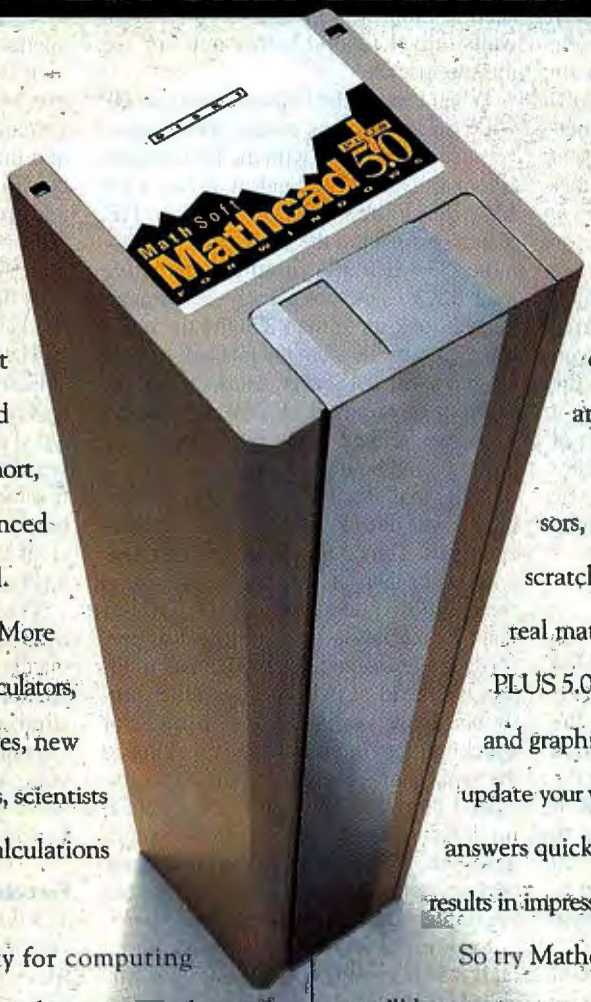
Setup

Setting up the FAServer was a snap. All I had to do was let it warm up (it arrived when the outside temperature was 10°F), plug it in, and cable it up. The only glitch was a VGA board that must have worked loose in shipping. Once I discovered how to get into the box and reseat the board, the system came up perfectly.

During the installation process, I had to type in four essential pieces of information: the node name, its IP address and netmask, and the local time zone. I also entered an administration host name; if this is not specified, any node on the network will have root access.

After I provided this information, the

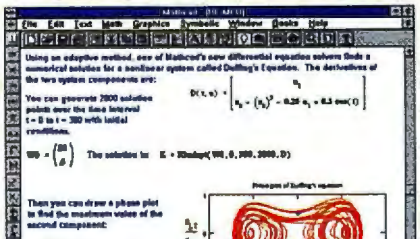
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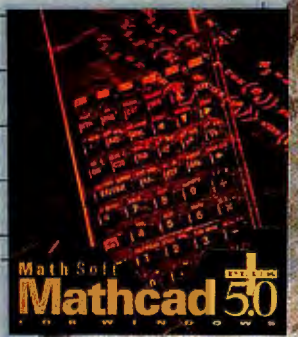
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FAServer immediately came up on the network. I then went to the administration host and edited the FAServer's `/etc/hosts` file to add the other systems on the network. Note that the FAServer software doesn't yet support any of the network name protocols (NIS or BIND), so it relies on several files in its `/etc` directory for network information.

After adding some of the systems on the network to the `/etc/hosts` and `/etc/exports` files and mounting the FAServer's file system on the clients, I started copying files to and from the FAServer. It was surprising just how quickly the FAServer responded to some systems; it provides better response than a number of general-purpose computers with faster CPUs. And it was an even bigger surprise to see how slowly the FAServer appeared to respond to some slower systems that I tested.

Testing

Used with a DECstation 3100 running Ultrix 4.1, the FAServer ran like a breeze. Copying a 4,058,924-byte file from the DECstation 3100 to the FAServer took 1 minute, 19 seconds, and copying the file in the other direction took 21 seconds. It took 27 seconds to create a 10-MB file on the FAServer from the DECstation 3100 (no local disk I/O); this is in contrast to the 24 seconds it took to create the file on a local disk.

The above numbers were gathered on a relatively quiet network (i.e., there was no network file activity). I had also flushed Ultrix's I/O caches by doing a lot of other I/O before starting the tests.

It was not unusual to see "NFS server xxx not responding, still trying" messages while copying a file from the DECstation 3100 to the FAServer. I never saw the messages when copying in the other direction. Technical support at NAC explained that the FAServer can turn packets around a lot faster than some clients can see them, which results in time-outs.

A *time-out* is the amount of time that elapses before the client tells the server that it missed a packet. If the time-out has been set to the default of 30 seconds, then the client effectively waits 30 seconds before notifying the server that a packet is missing. Reducing the time-out to the 1-second minimum means that the client waits only 1 second before noticing the missing packet.

When I tested the FAServer with an HP 9000 Series 7000 as client, performance was even faster than with the DECstation. It took only 15.31 seconds to create a 10-MB file on the FAServer from the HP. When performing the same tests on a no-name 33-MHz 386 running Interactive Unix 3.2.2, I saw substantially slower numbers. It took more than 2 hours to copy a 891,110-byte file from the Interactive Unix system to the FAServer, and I aborted the attempt to create a 10-MB file on the FAServer from the Interactive Unix system after about 2 hours.

NAC explained that this slow performance was due to the time-outs and packet resends: The FAServer sent packets back a lot faster than the clients could process them. NFS typically uses the UDP (User Data Packet) data-layer protocol to perform data transfers; since UDP has minimal overhead, it is faster than other protocols. However, UDP does little error checking, leaving reliability checking to the application—in this case, the NFS server and clients. Although there are TCP implementations of NFS to ensure a reliable link at the cost of added overhead, they are not in wide use, and NAC has not yet implemented them in the FAServer.

I experienced similar problems with a Dell 320SLi running DOS 6.0 with Microsoft Windows 3.1, FTP Software's PC/TCP with Interdrive 2.2, and Xircom's Ethernet CreditCard with version 2 of its software. However, the FTP Interdrive (NFS) software installed on that system was much more configurable than the Interactive Unix software, and I was able to reduce the time-outs. Although I then saw better throughput on the Dell, it still did not match the throughput seen with the faster clients.

NAC plans to replace the version 1.2 software I reviewed with version 2.0 in late July. The new version will support DNS (Domain Name Service), a TCP/IP network name protocol.

About the Product

FAServer 400 .....$16,995
(with 16 MB of RAM, Ethernet port, two 1.08-GB hard drives, monochrome monitor, and keyboard)

Network Appliance Corp.
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Mountain View, CA 94043
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Administering the FAServer

You can administer the FAServer directly through its console terminal, remotely through a telnet session (only one is permitted), or through SNMP (MIB-II [Management Information Base] is supported). You don't have most of the commands that would be available on typical Unix systems, such as editors, directory listers, and the like. Nor do you have direct access to the file system itself. In fact, to add additional clients, you have to edit the `/etc/hosts` and `/etc/exports` files on the FAServer from an NFS client (typically the administration client system specified at installation).

The FAServer telnet session and console are linked together—a useful security feature. When the console password is typed on the FAServer console and a telnet session is active to the FAServer, commands and output on either appear on the other. Unfortunately, there are no provisions for hard-copy output; the FAServer has no serial or parallel ports.

The FAServer also supports the SNMP MIB-II agent protocol and provides commands to query and update the MIB. These are not configured in by default, and if desired, you must hand-edit them into the start-up file at installation time. Of course, your site must have the appropriate network management software to take advantage of this feature.

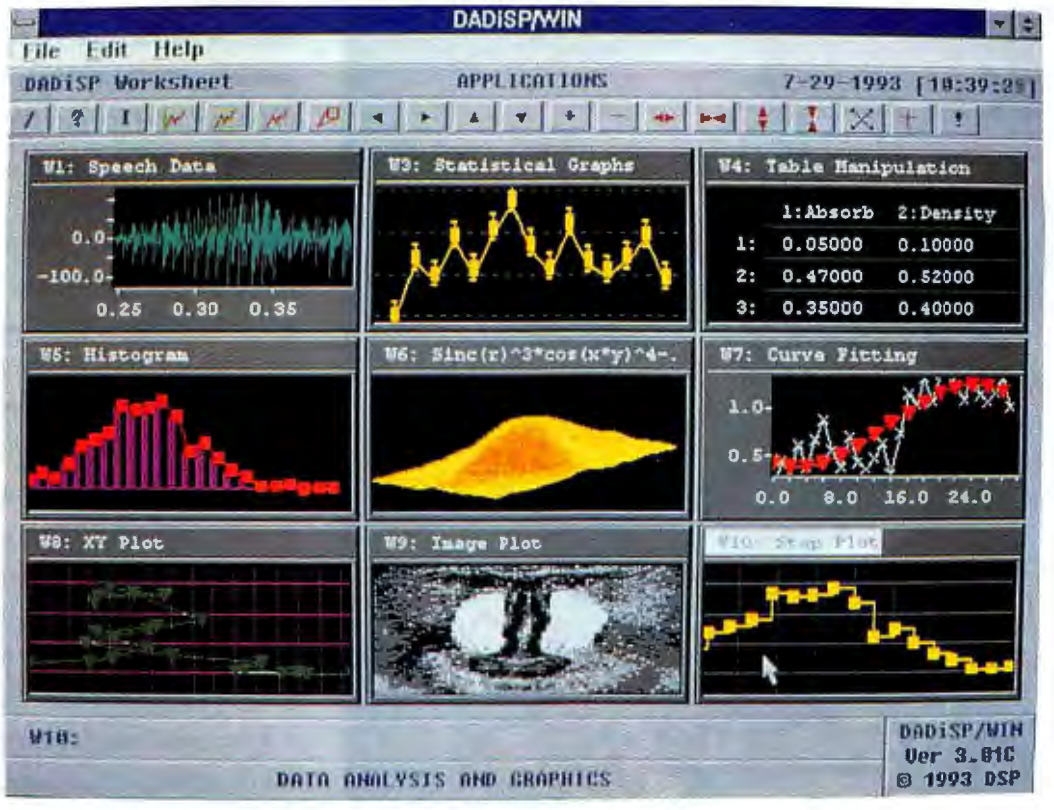
Fast and Easy

The FAServer gives excellent performance with fast clients, copying megabytes of files over an Ethernet connection in just a few seconds. However, its quick response time caused problems with slower clients, in some cases slowing file transfers to a snail's pace. If you have slower NFS clients on your network, I'd recommend waiting for a release of FAServer software that can slow its response to match that of the client.

Because of NAC's WAFL file system and RAID-4 optimizations, the FAServer's performance will hold steady regardless of the number of disks on the system. As important as performance to most people, however, will be the FAServer's ease of installation, administration, and expansion, together with the convenience and data reliability of its snapshot file system. A starting price of $16,995 doesn't hurt, either. ■

Bruce Dawson is a consultant working for Virgin Software, Ltd. (Manchester, NH). He has been developing low-level Unix, VMS, and DOS applications for the last 10 years. He can be reached on the Internet at jbd@virgin.mv.com or on BIX c/o "editors."

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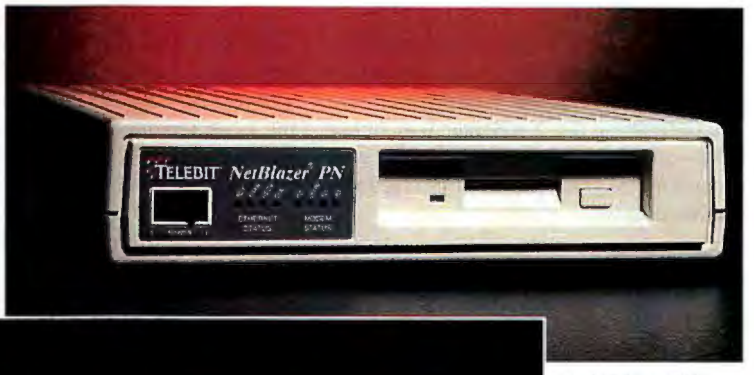
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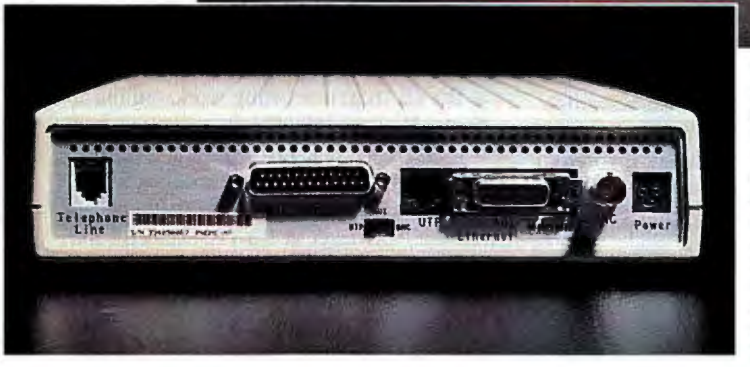
Dial-Up Networking

Telebit's NetBlazer PN1 remote router provides affordable WAN connections over both dial-up and leased lines

BRUCE DAWSON



The NetBlazer PN1's front panel provides activity lights for both Ethernet traffic and modem traffic. A 3½-inch floppy drive provides for initial booting and is one of several means of configuration. The NetBlazer can also boot off an IP network.



The NetBlazer PN1 provides all three types of Ethernet connection (AUI for thick coaxial cable, BNC for thin coaxial cable, and RJ-45 for twisted-pair cable), a phone connection for its internal V.32bis modem, and a 25-pin serial port for attaching a second modem.

When distance rules out direct connection, remote routers let you extend your LAN to distant sites over phone lines. You can, for example, tie smaller LANs at field offices into a bigger corporate LAN, creating a WAN (wide-area network). Telebit's NetBlazer line provides on-demand remote routing as well as remote-node and modem-sharing functions over both dial-up phone lines and leased lines.

The NetBlazer PN1 I review here is an integrated V.32bis modem and Ethernet router with a serial port for connecting a second modem. Introduced earlier this year, Telebit's PN models are the low end of the NetBlazer line. Like other NetBlazers, the $2699 PN1 understands IP (Unix), IPX (Novell), and EtherTalk (Apple) network protocols.

With a NetBlazer attached to your Ethernet LAN, remote users can dial in to the LAN, and your LAN can dial out to other router-equipped LANs or to on-line services. Two multiprotocol networks equipped with NetBlazers can act as one LAN, except for the slower transmission over phone lines and the delays of forming connections on demand. NetBlazers work with dedicated leased lines, too, both synchronous and asynchronous.

There are several PN models. While the PN1 has a built-in 14.4-Kbps modem and single serial port, the modemless PN2 ($2299) has two serial ports (configured as DB-25 DTE [data terminal equipment] ports, following the RS-423/RS-232 standard). The PN4 ($2999) has four serial ports for remote communication. The PN2, PN1, and PN4 Hub models ($2999 to $3699) each have WAN connections corresponding to the non-Hub models, but they include a built-in eight-port 10Base-T hub instead of a single Ethernet connection. You can cascade Hub models with hubs from other manufacturers.

All PN models fit in the same stackable case, with a footprint slightly larger than a legal pad. If you need more than four WAN connections at a site, the larger NetBlazer ST and NetBlazer 40 routers provide up to 18 and 26 serial ports, respectively, and up to three LAN connections.

Serial Connections

Although they support leased lines, NetBlazers specialize in dial-up connections. The PN1's built-in modem is a 14.4-Kbps V.32bis unit with a potential throughput of up to 52.2 Kbps with V.42bis compression. If the single 14.4-Kbps modem doesn't offer sufficient throughput, you can connect a second modem to the NetBlazer PN1 and gain a higher aggregate throughput. The PN1 will automatically load-balance IP traffic between the two lines. (AppleTalk and IPX are restricted to single-line connections.)

Using faster Telebit modems on the PN1's serial port, you can see unidirectional throughput as high as 115 Kbps on asynchronous lines and 128 Kbps on synchronous lines. NetBlazer serial ports can support new 28.8-Kbps V.34 modems.

The NetBlazer PN1 has three types of Ethernet media connection (10Base-T, thinnet, and thicknet), an RJ-11 phone jack, an Ethernet media selection switch, a DB-25 DTE serial port, and a power-adapter jack. The front panel provides comforting sets of lights—one set for Ethernet traffic and another for modem traffic. The front panel also has a 3½-inch floppy drive that provides for initial booting and configuration. Once configured, NetBlazers can boot off the network (with IP only).

Setting Up the NetBlazer

I was particularly interested in the NetBlazer's dynamic or on-demand routing capabilities. The router dials up a remote network only when someone runs an application that attempts to access resources on that network. The NetBlazer breaks the connection when activity through the routing connection ceases, saving phone charges. (You configure the time-out.)

I also tested the NetBlazer's remote-node dial-in and modem-pooling dial-out capabilities. A remote node is a single PC, equipped with a modem, that can dial in to a NetBlazer and become a node on a network. Pooling allows network users to share one or more high-speed modems to dial out to on-line or BBS services. IPX requires the Telebit's optional ACS software to pool.

continued

I installed a NetBlazer PN1 at the BYTE offices in Peterborough, New Hampshire, and configured it for all three of the network protocols that it supports: IP, IPX, and AppleTalk. I installed an identical NetBlazer on my home LAN, which is solely an IP network. I configured both as PSTN (Public Switched Telephone Network) routers. Once connected, the two Class-C IP networks acted as one; I became an interactive user on BYTE's network, sharing files, printing files, and sending mail.

Configuring the NetBlazer was rather easy—after I read the manual. Telebit provides for several methods of configuring the NetBlazer:

- a Microsoft Windows interface that configures the NetBlazer either through its serial port or over an IPX connection
- a built-in, user-extensible command-line interface accessed either through the serial port or via telnet once the modem has been configured; you log in to the NetBlazer to use it
- an MS-DOS file loaded from its floppy drive
- via SNMP, either locally or remotely

I used all methods except the SNMP interface and was most pleased with the Windows interface for initial configuration. The command-line interface was useful for fine-tuning and debugging, but the Windows interface appeared to support all the options that the command-line interface provided and supplied an extensive help facility, too.

The floppy drive configuration method uses a DOS floppy disk (but does not contain a DOS boot block, so the NetBlazer doesn't run DOS or DOS programs). The configuration information is in ASCII text files, so you can edit the files on a DOS-based PC and the NetBlazer will then read them. Sites with a large number of NetBlazers may find this method useful for issuing sitewide configuration changes.

With IP and AppleTalk you can enable callback security. You can also employ a cryptographic method of authenticating identity if both ends are NetBlazers. With IPX, you only need a NetBlazer at one end to use the cryptographic method if the other end is a remote PPP client.

Although one of the NetBlazer's nice IP features is that it can support multiple remote networks as the same IP subnetwork, the two test networks already had different IP addresses. Therefore, in configuring the two NetBlazers as routers at each end of the dial-up connection, I had to inform the target systems at both sites that the NetBlazers were serving as gateways between the two networks. (IP hosts have to broadcast routing information if they want to be known further than the local network.)

I repeated the same sequence on the NetBlazer at the BYTE offices using numbers appropriate for the network there, and we were theoretically connected. After fixing a configuration problem caused by the phone company's changing the dialing instructions for my home phones, and replacing a frayed Ethernet cable at BYTE, the connection was up and running.

Theory Is Practice

The gap between theory and practice was small when, using the `rlogin` command, I tried remotely logging in to a workstation at BYTE from one of my workstations at home. You can imagine my surprise when it worked. It took just under 30 seconds for my NetBlazer to determine that the `rlogin` packet had to be routed, dial the remote NetBlazer at BYTE, establish the connection, exchange routing information with the other NetBlazer, and route the packets to a workstation at BYTE. The seamless and turnkey nature of the whole operation was impressive.

I roamed the network a bit at BYTE, NFS-mounted (Network File System) some BYTE disks on my system at home, and then logged out. Five minutes later, I tried getting a directory listing of one of the remote disks I had mounted. After another 30-second pause to connect, the directory listing appeared on my monitor. Subsequent disk accesses were faster as the connection was maintained.

Once the connection was made, it took 30 seconds to copy a 38,000-byte text file from a remotely mounted NFS disk to a local disk. A file containing all 0s took only 12 seconds due to the built-in modem's V.42bis compression.

That the NetBlazer automatically drops the phone line after it's been idle for a configurable period can save oodles of money in long-distance phone charges with infrequently used systems. As good as this sounds, however, the protocols used by programs like `rlogin` and `ping` are constantly sending packets to query the state of the other side. Using these applications prevents the NetBlazer from perceiving the line as idle; therefore, it won't drop the line until you stop these applications. (Under IPX, the NetBlazer software can spoof SAP packets so they won't keep a connection open unnecessarily.)

Remote Access

When someone dials in to the NetBlazer, it will, by default, prompt for a user name and password. When you first power up the NetBlazer, the only user is `root`, with no password. It is then up to you to assign a password to the root account to prevent random people from using that account to reconfigure the modem. Note that you can create other accounts that permit modem configuration.

With any NOS (network operating system), many users are possible, and a NetBlazer must know who they all are through its user database. The NetBlazer's firmware lets you load the user database from its command line, a floppy disk, a network host, or the DNS (Domain Name Service).

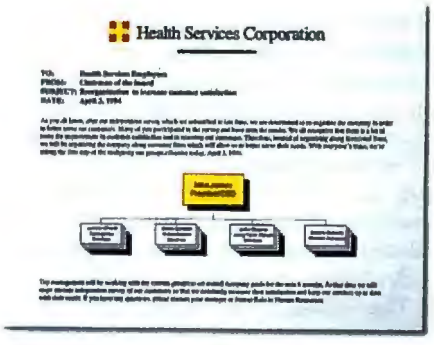
The NetBlazer allows you to create user records for each potential user of the NetBlazer. Each record specifies the user's log-in name, a password or cryptokey, the user's permissions (i.e., command restrictions), and a command to execute upon log-in. You can also configure the NetBlazer to read a remote Unix system's `/etc/passwd` file so that a particular system's users can log in to the NetBlazer. Note that users explicitly created on the NetBlazer will have parameters that override any parameters read from the network.

The NetBlazer's user database file is similar in format to Unix's user database, `passwd`, sharing the same filenames and internal line format. However, the NetBlazer ignores several fields (e.g., the user and group number fields) and attaches special meaning to the comment (fifth) field of the `passwd` file.

To test the NetBlazer's dial-in capabilities, I dialed in to it with a dumb terminal and remotely logged in to workstations at that site using the `rlogin` command. Prior to doing this, I had to log in to the NetBlazer as user `root`, create a user account for myself, and enable the account for telnet access. Then, once logged onto the NetBlazer under my own account, I could issue an `rlogin` or `telnet` command to any of the systems on the Ethernet LAN.

The NetBlazer presents itself to interactive users as a Unix system with a log-in and password prompt, but it has only a limited set of Unix-like commands to choose from. I wasn't able to issue an `rlogin` command to any of the workstations at the remote site, because I had dialed in to the modem line that the NetBlazer would have used to dial out to the

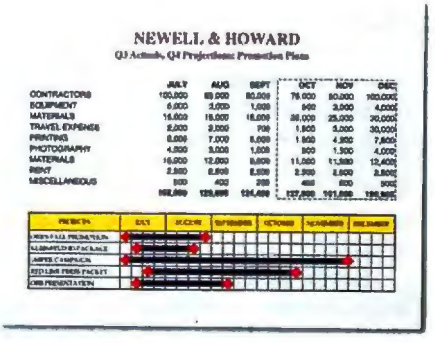
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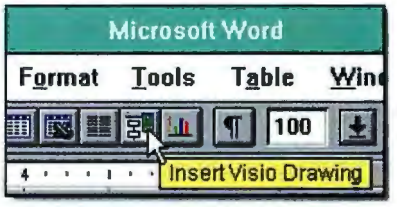
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remote site. However, if the two NetBlazers had been equipped with second modems, it should have worked.

Modem Sharing

A network user who wishes to dial out through a modem connected to the NetBlazer must log in to the NetBlazer and issue a `session dial` command. The NetBlazer first ensures that the user has dial-out permissions and, if so, dials out. An administrator can configure the NetBlazer so that any user-provided phone number can be dialed or so that certain users can dial only certain sites.

It isn't easy to make the NetBlazer totally transparent to dial-out users. However, you can create a NetBlazer user account that dials another modem (e.g., create a NetBlazer user called `compuserve`) and set the user's profile to automatically issue the `dial` and `logout` commands so that the log-out command is executed after the dial completes and logs the user off the NetBlazer. Network users can then telnet to the NetBlazer and log in to the `compuserve` account.

The NetBlazer has commands you can use to maintain the phone number and dial-out databases. Users with configuration permissions can update these databases, along with other configuration parameters. (The configuration privilege is the most powerful NetBlazer privilege.)

To see how well the NetBlazer performed as an Ethernet modem pool, I logged in to my account on the NetBlazer from a workstation using telnet and issued a dial command to a local access point for an on-line service. The NetBlazer promptly dialed the specified number and connected me.

I subsequently tried dialing the other NetBlazer at the remote site, hoping that I wouldn't run interference with Ethernet traffic, and the whole process went very smoothly. The remote NetBlazer presented me with a log-in prompt, and I was able to log in as a normal user. When I tried to dial yet another modem, knowing that I was on the remote NetBlazer's only modem, I got an appropriate error message.

Making AppleTalk

After getting the IP network going, I tried the NetBlazer's AppleTalk routing. The PN1 can also serve as an ARA (AppleTalk Remote Access) router and an ADSP-capable modem. One serial port can work both as an AppleTalk router and an ARA remote-node server. The NetBlazer uses AppleTalk Phase 2 packets. ARA requires only that your Mac have Apple's System 7 operating system.

Configuring the NetBlazer for AppleTalk was relatively straightforward. I had to know the zone names in use at each site. My site was easy—I just looked at the Chooser—but I had to call someone at BYTE to determine that site's zone names.

After providing the necessary routing information on both NetBlazers (home and BYTE), I assumed that I was now ready to run an application on the Mac at home and print on a LaserWriter at BYTE. However, that wasn't the case. After a lot of fussing, I finally called Telebit for help.

Telebit indicated that after setting up AppleTalk routing, I should reboot the NetBlazer. This wasn't documented anywhere that I could find, but it worked. After rebooting both NetBlazers, I could use the applications on the Mac at home and print on printers at the BYTE offices, share files with other Macs at BYTE, and even access the Novell file servers, Shiva NetModems, and other AppleTalk resources at the BYTE office.

NetWare PPP

The NetBlazer supports IPX as a dial-in modem accessible by PCs using the included PPPShell program, as an IPX router, and as an IPX modem server. (The latter requires the ACS option, which I did not test.)

Because I was most interested in telecommuting and I didn't have Novell servers on my home network (much less a full Novell network), I only verified the NetBlazer's abilities as a dial-in modem for PCs using PPPShell. But Telebit's IPX instructions are straightforward, and the NetBlazer has sufficient debugging primitives to help you out of any holes you may configure yourself into.

In setting up the NetBlazer for remote IPX access, the two sides must agree on their configurations. The network side has a NetBlazer and a user log-in set up for each PC workstation that can dial in. The PN1 will support numerous workstations, but only one (or two with an external modem) can use the NetBlazer PN1 at a time.

You configure the dynamic interface for the PC workstation just as you would for IP or AppleTalk networks. The only difference is that the workstation's name, the NetBlazer's interface name, and the NetBlazer's user log-in record must all match. Also, because Telebit's remote shell is PPP-based, the dynamic interface must use PPP (instead of SL/IP or ARA).

You then create a user log-in for the workstation, using the provided floppy disk–based installation software. Again, the user name, workstation name, and interface name must all match the information the NetBlazer has. Once I got the configuration out of the way, I was pleased with how easy it was to use. You just run a batch file command from the remote PC, wait about 35 seconds, and then run `login`, and you're on the network.

Fairly Rosy

I found no obvious bugs in the NetBlazer hardware or software. Any failures could be attributed to network and configuration problems, not the NetBlazer—it was far more reliable than the networks I ran it on. As with any product this complex, I did run into setup problems. But the Telebit technical people were very helpful in resolving such problems and answering questions. The people I talked with exhibited a good grasp of the networking technologies and protocols involved.

The NetBlazer has all the features I'd want in a remote router, except one: something to make administration a bit easier and more customizable from a remote site. An `rshd` (remote shell daemon) would permit command execution from a remote system to do things like query the state of one or more interfaces or list the users. With a product as sophisticated as this, it's likely some customers would develop their own management scripts, and `rsh` is a logical interface for that.

The NetBlazer PN is a superb networking product offering a variety of features from multiprotocol routing to modem pooling, with a strong management command set. Once it's configured, its operation is reliable and nearly seamless. If you need to link IP, IPX, and/or AppleTalk networks over distance, and several fast modems are enough to handle the traffic, then this could easily be a must-have product. ■

About the Product

NetBlazer PN1 ..... $2699
Telebit Corp.
1 Executive Dr.
Chelmsford, MA 01824
(800) 835-3248
(508) 441-2181
fax: (508) 441-9060
Circle 1076 on Inquiry Card.

Bruce Dawson is a consultant working for Virgin Software, Ltd. (Manchester, NH). He has been developing low-level Unix, VMS, and DOS applications for the last 10 years. You can reach him on the Internet at jbd@virgin.mv.com or on BIX c/o "editors."

Forecasting the Future

You no longer need to be a statistician to generate sophisticated business forecasts

GEORGE STEWART

Software-based business forecasting is not new, but it has been limited to a select group of professionals who understand the methodologies and terminologies of forecasting. Now a new class of forecasting software incorporates the decision strategies used by statisticians while guiding nontechnical businesspeople through a forecasting session much as a statistical consultant would.

The four programs featured in this review—Forecast Pro for Windows, SmartForecast, Solo Statistical Software, and Autocast II—generate forecasts based on real-world data known as *time series*. A time series is a set of observations taken at regular intervals; for example, a retail-store chain's weekly sales, a family's monthly electricity usage, or the number of individuals applying for unemployment benefits each quarter. Using such data, the forecasting programs predict what will happen in the near future: expected sales, next month's electricity usage, or future unemployment figures.

In this review, I evaluate products that focus primarily on time-series forecasting and on making forecasting available to the lay person. I have not included large, general-purpose statistical software.

The Nuts and Bolts

The first step in the statistical forecasting process involves collecting the time-series data. Depending on the circumstances, you may need as few as five or six annual observations or as many as several thousand, taken at regular intervals. The data may already exist in a computer database or spreadsheet, or it can be entered manually into the program itself.

All the programs accept univariate data (i.e., data involving a single variable). Some of the programs accept multivariate data. An example of multivariate data would be a time series showing average daily electricity usage and average daily temperature. Multivariate data can treat one independent variable as a leading indicator for another, dependent, variable.

The second step in forecasting is to analyze the time series. The programs apply a battery of statistical tests to the data, providing you with an array of graphical and numerical information. This information helps you determine whether the data contains certain characteristics relevant to forecasting: fluctuation around a constant level, a rising or falling trend, a seasonal pattern, or a nonseasonal cycle. You might also discover irregularities in the data that could have an impact on the forecast's reliability.

Using information from the data analysis, you select a mathematical model for the time series. Forecasting software selects or recommends the model to use and then implements the selected model. You never have to deal directly with the formulas.

With the model selected, you generate a forecast for a limited number of observation periods. Forecasts are typically limited to one cycle of observation periods (i.e., 12 months, four quarters, or 52 weeks into the future). However, where the time series consists of annual observations made over several decades, the forecast horizon might include up to 10 annual predictions. Forecast validity decreases rapidly as the forecast is extended beyond one cycle of observation periods.

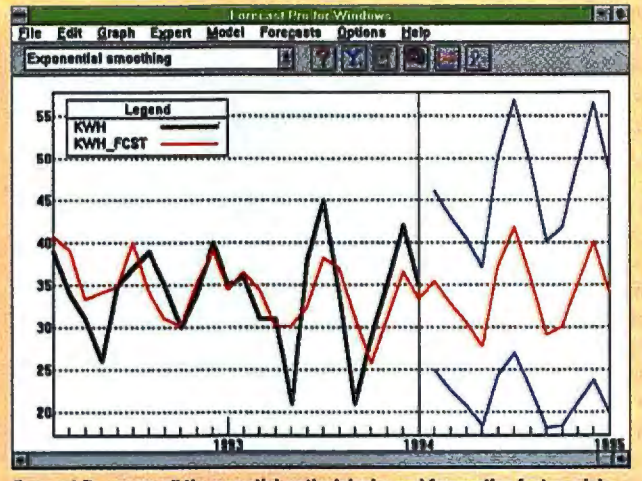
A final, essential step in the process is attaching levels of confidence to the forecast. In addition to predicting specific numbers, the forecast must estimate the probability that the actual data will be above or below this prediction. Typically, the forecast specifies a 95 percent confidence level associated with each prediction (i.e., a range within which the actual data is expected to fall with a 95 percent probability).

For practical purposes, this confidence level is more important than the actual predicted value. For example, to avoid running out of stock, a purchasing agent using a forecast to predict inventory requirements may find it prudent to order sufficient quantities to satisfy the 95 percent confidence level, rather than simply ordering the most likely forecast.

In evaluating and comparing the programs, I have considered the following characteristics: variety of forecasting methodologies offered; ease of use; quality of output, both numerical and graphical; degree of expert assistance provided; and flexibility or ability to customize the forecasting methods. I ran all the programs on a 66-MHz 486 Gateway system (the 486 has an on-chip math coprocessor). Even when processing a time series of several hundred observations, results came back almost instantaneously.

FORECAST PRO FOR WINDOWS

Forecast Pro for Windows, from Business Forecast Systems, is the only reviewed package that runs as a full Windows application, so it provides some built-in



Forecast Pro wraps all the essential methodologies and forecasting features into an elegant Windows interface. It provides an efficient audit trail and DDE links to Windows spreadsheets and word processors. Shown here is a graph of the forecasted values along with confidence intervals (displayed on the right).

Forecast Pro for Windows

Runs under Windows 3.x, NT, or OS/2 2.x

Supports up to 50 variables

(Extended edition supports 100 variables)

Methodologies

- Simple moving averages
- Exponential smoothing
- Box-Jenkins
- Dynamic regression

advantages—such as DDE links between Forecast Pro and your other Windows applications. Three of Forecast Pro's supported methodologies are univariate (i.e., they look only at the behavior of a single variable). Dynamic regression calculates the relationship between a dependent variable and its historical values as well as the historical values of one or more independent variables.

Forecast Pro's audit-trail window operates as a notepad for automatic storage of the statistical data and expert advice generated by the program during the entire session. The notepad can be edited, stored, or printed. This important feature has no exact counterpart in the other programs.

To begin working with data, you click on the Tableau tool. The data tableau is where you specify the variables (univariate time series) you want to forecast or analyze. Available variables are displayed in a list box. If you select more than one variable, the first variable selected in a given tableau is treated as the dependent variable, and subsequent variables are treated as independent. After selecting one or more variables, you specify the portion of the time series to be considered and the number of forecasts desired. The program allows you to "hold out" a given number of observations from the end of the time series; you can then generate a forecast for the hold-out period and compare the forecast with what actually occurred in the period.

The next step is to view the data graphically. You can look at a plot of all the variables selected in the tableau. The graphs help you identify characteristics of your variables and relationships between them. You can also adjust the data by pointing to a location on the graph and dragging the value up or down. This shortcut lets you get rid of irregularities in the data that you do not want included in the forecast—for example, you might want to smooth out a "blip" caused by a freak occurrence.

To pick a forecast methodology, you select the Expert tool, which automatically performs a battery of data exploration tests, identifies the characteristics of the series, and recommends a forecasting model. The Forecast tool generates the forecast according to the selected model. You can then copy the forecast data to the audit trail and plot the forecast, along with the confidence limits.

You can save forecasts and recall them later for comparison with subsequent forecasts using different models. For instance, having forecast the variable KWH (kilowatt-hours) using Box-Jenkins, you might then forecast KWH using exponential smoothing and compare the two forecasts by recalling the Box-Jenkins model.

When you specify your own model (rather than relying on the Expert recommendation), Forecast Pro gives you plenty of flexibility in combining the applicable parameters. For example, under exponential smoothing, you can select simple, Holt, Winters, or a Custom model. The Custom model lets you specify the trend (none, linear, or damped) and seasonality (none, multiplicative, or additive).

Forecast Pro also includes a batch mode for forecasts (univariate only) of up to 50 time series without need for your intervention. Dynamic regression is not available in batch mode.

Forecast Pro offers only rudimentary facilities for entering and editing time series. For instance, if you inadvertently omit an observation from the middle of a series, you can't insert the number into the series; you must retype the series beginning with the omitted value. You'll probably choose to enter your data from a spreadsheet, editor, or database application.

Overall, the program and its documentation are designed to make forecasting an interesting and enjoyable process for the total beginner. At the same time, the program has the power and flexibility a more experienced forecaster would require.

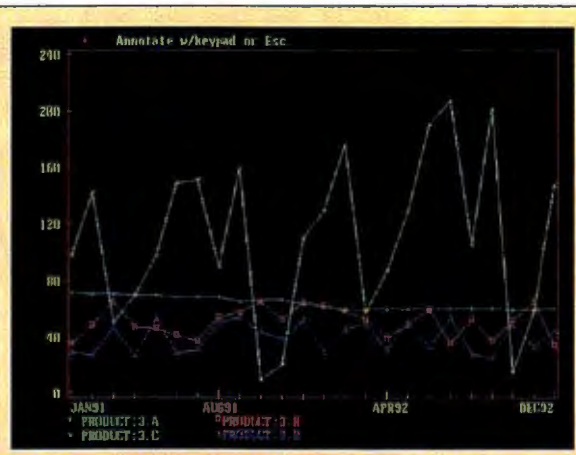
SMARTFORECAST

SmartForecast opens with a spreadsheet window and a menu. Each column in the spreadsheet corresponds to a variable, and each row to an observation. You can enter data directly into the spreadsheet or load it from a disk file. As with Forecast Pro, this program automatically labels the rows according to the time of the observation. Data entry and editing under SmartForecast are particularly convenient. For example, you can insert a value in the middle of a time series, and you can define new variables by transformations on existing variables.

Data analysis is straightforward under SmartForecast via the Explore mode. For instance, the Correlate option works on a single variable to show autocorrelations (e.g., seasonality), or on two variables to determine whether one variable may be a leading indicator of the other. Results of the computations can be copied into a new variable in the program's built-in spreadsheet. The upper and lower confidence limits, the forecast, and the fit (i.e., values of the model during the base period) can be saved individually to the spreadsheet. You can output the tabular results to a printer, but, regrettably, you cannot save them to disk (compare this with Forecast Pro, which keeps all the statistical reports in an audit trail).

Having completed the analysis phase, SmartForecast selects a model or lets you choose your own. As with Forecast Pro, you can specify the applicable parameters for each methodology chosen. The Multiseries option produces automatic forecasts of up to 60 related variables and a total of these forecasts. This is a convenient feature for forecasting sales of an entire product line, for instance.

The Eyeball option lets you adjust forecasts manually using "business judgment" or "management overrides." The feature is intended to give you greater flexibility and



SmartForecast

Runs under DOS 3.0 or higher

Supports up to 60 variables (260 observations per variable)

Methodologies

- Simple moving averages
- Exponential smoothing
- Box-Jenkins
- Dynamic regression

SmartForecast is a comprehensive forecasting program with an intuitive keyboard interface, but it lacks the design elegance of Forecast Pro. With its graphical display of multivariate data, SmartForecast highlights data dependencies.

control, but it seems ill-conceived. The program does not document the manual changes made in the forecast graph, and a person looking at the forecast after the fact could get the mistaken impression that the graph was generated by objective methods.

SmartForecast is a comprehensive forecasting program with an intuitive keyboard interface (i.e., single-key command menus and submenus). You can maneuver quickly through the program to generate automatic or customized forecasts. However, it lacks the design elegance of Forecast Pro. For example, there's no convenient way to export tabular statistical results to disk for further incorporation into word processing documents. The program also lacks a convenient way of holding out data to verify forecasting accuracy. (You can, however, perform hold-outs indirectly by copying the time series into a new variable and inserting "missing" values for the period to be held out.)

The Batch Processing Edition of SmartForecast lets you make forecasts involving hundreds of individual data files and thousands of time series, using automatic model selection or a model you specify in advance.

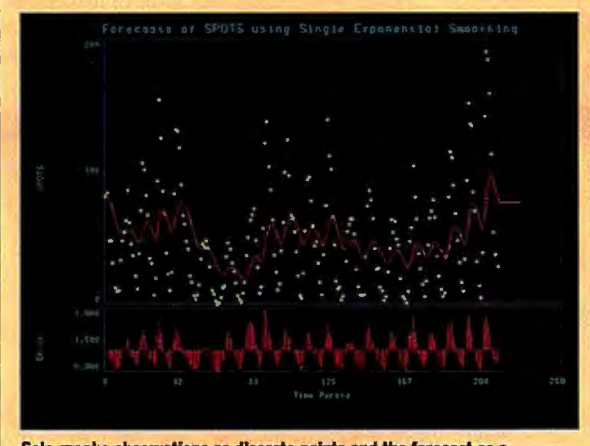
SOLO STATISTICAL SOFTWARE

This DOS-based package from BMDP Statistical Software consists of a Base System plus optional modules, including the Forecasting and Time Series module reviewed here. The Base System offers simple moving averages and exponential smoothing. The FTS module adds Box-Jenkins and harmonic regression methodologies.

From Solo's Transfer menu, you select the Base System functions as well as add-on modules such as FTS. The program contains a spreadsheet with editing capabilities, such as selective copying and erasing of observations. Unlike Forecast Pro and SmartForecast, this program does not have a facility for automatically labeling observations (rows) by the date of observation; you must do this manually. And even if you take the trouble to label rows according to the time, dates do not appear in the output; the program simply references the time variable by the row number in which the data appears. Solo does include a number of transformation functions and keyboard macros to automate repetitive tasks.

To begin data analysis in Solo, you select the Time Series menu. Three of the options facilitate manual analysis without expert recommendations. Another option performs classical forecasting (i.e., linear trend, single and double exponential smoothing, season plus trend multiplicative, and season plus trend additive). In addition to specifying a forecasting method, you can specify the values of the smoothing constants. Only the Box-Jenkins forecasts are accompanied by explicit confidence limits.

The forecast output appears as a graph, where observations are discrete points and the forecast is shown as a continuous line. This makes it somewhat difficult to visually gauge the goodness of fit between the model and the historical data. On the plus side, Solo lets you designate a report file to contain all statistical output from the program.



Solo

Base System 4.0 with Time Series and Forecasting module

Runs on DOS 3.x

Supports up to 500 variables (32,000 observations total)

Methodologies

- Simple moving averages
- Exponential smoothing
- Box-Jenkins
- Harmonic regression

Solo graphs observations as discrete points and the forecast as a continuous line. This makes it somewhat difficult to gauge the goodness of fit between the model and the historical data. Compared to Forecast Pro and SmartForecast, Solo is difficult to learn and requires a greater level of knowledge about statistics.

Compared to Forecast Pro and SmartForecast, Solo is difficult to learn and requires a greater level of knowledge about statistics.

AUTOCAST II

Autocast II, a DOS-based program from Delphus, provides single-variable forecasting based on exponential smoothing. It is the simplest to use of the four programs reviewed. And because of the general applicability of exponential smoothing, the program is fit for a wide range of uses.

For inputting data, Autocast II includes a single-variable "worksheet" for entering a time series. You can also import data created with Lotus 1-2-3 or other programs, so long as the data is properly formatted. Associated with each Autocast II data file is a short description of the data, the season length, and the beginning date of the time series. Therefore, it is not necessary to manually specify the dates of each individual observation, as with Solo. Autocast II's data editor also lets you insert and delete records, which is handy when you inadvertently omit an observation in the middle of a series.

After you have entered or loaded a time series, you are ready to have Autocast II prepare an initial automatic forecast, based on its own expert estimation of the most appropriate exponential smoothing model to use. It is appropriate to go directly to automatic forecasting in this program, skipping the model-selection stage, since all the modeling is done with exponential smoothing.

On the graph, historical data appears as a solid line, and forecast and modeled values appear as discrete points. Confidence limits are shown with solid lines. The use of discrete points to show the modeled data makes comparison with historical data a little difficult (as with Solo).

For refinement of the model or possible selection of an alternative, you use the Analysis menu. You compare the plot to a set of forecast profiles (graphs of the profiles appear in the manual). Such a comparison could suggest, for example, that a particular time series exhibits multiple seasonality with a linear trend.

For further assistance in selecting a model, you can examine variance, autocorrelation, and the use of transformations to increase the stationarity of the data (i.e., remove long-term trend effects). The instructions for evaluating this information are simple and to the point. The variance and autocorrelation options do not change anything, but they give you information

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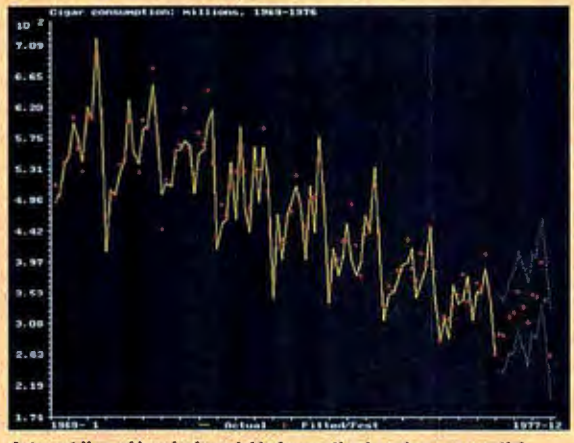
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Reviews Forecasting the Future



Autocast II provides single-variable forecasting based on exponential smoothing. It can display data, a graphical depiction of the forecast model, and confidence intervals.

Autocast II

Runs on DOS 3.x

Univariate (one variable only)

Supports up to 500 observations

Methodologies

- Exponential smoothing
- 4CAST/2 from Delphus, a separate product not reviewed here, adds other methodologies, including Box-Jenkins

useful in making a manual model selection. The autocorrelation option lets you perform indicated transformations on the data. Multiple transformations are allowed.

The program makes it so easy to modify the forecasting model that you can quickly lose track of the current model, so it's essential that you print a model-fitting report with each forecast. Unfortunately, the program does not allow you to store the model-fitting reports to disk. As a further means of testing the validity of a model, Autocast II lets you hold back part of the historical data, build a model using the remaining data, and compare the forecast with what actually occurred. As with Forecast Pro and SmartForecast, Autocast II offers a batch-processing module to allow automatic forecasting of multiple time series.

If you are looking for an easy-to-use forecasting program and your data does not require Box-Jenkins methodology, Autocast II is a good choice.

Caveat Forecasters

All four programs reviewed here offer expert-system forecasting for nonexperts. With the exception of Solo, all the programs are well suited to the lay person who wants to do statistical forecasting of time series without becoming too deeply involved in statistics.

Forecast Pro wraps all the essential methodologies and forecasting features into an elegant Windows interface. It is the only program reviewed that provides an efficient audit trail and DDE links to Windows spreadsheets and word processors. Forecast Pro strikes an optimal mix between the ease-of-use features that a novice forecaster seeks and the power and flexibility an experienced forecaster requires. ■

George Stewart is a former BYTE editor living in Hancock, New Hampshire. He has a B.A. in mathematics and a degree in law. He can be reached on the Internet or BIX c/o editors@bix.com.

About the Products

Autocast II 1.50.....$349
Delphus, Inc.
103 Washington St., Suite 348
Morristown, NJ 07960
(201) 267-9269
fax: (201) 285-1228
Circle 1078 on Inquiry Card.

Forecast Pro for Windows
Standard edition.....$595
Extended edition.....$995
Business Forecast Systems, Inc.
68 Leonard St.
Belmont, MA 02178
(617) 484-5050
fax: (617) 484-9219
Circle 1079 on Inquiry Card.

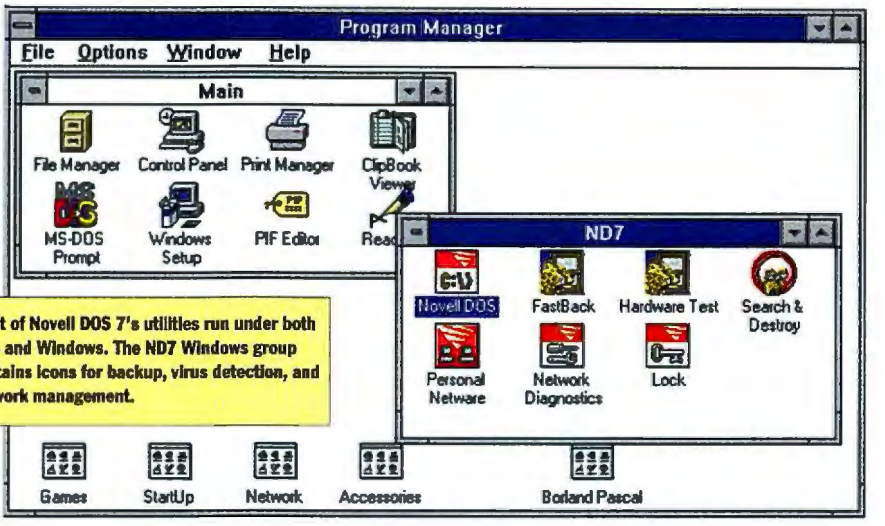
SmartForecast
Standard edition 3.0.....$595
Smart Software, Inc.
4 Hill Rd.
Belmont, MA 02178
(617) 489-2743
fax: (617) 489-2748
Circle 1080 on Inquiry Card.

Solo Statistical Software
Base System (includes graphics).....$195
Time Series and Forecasting module.....$95
BMDP Statistical Software, Inc.
1440 Sepulveda Blvd., Suite 386
Los Angeles, CA 90025
(310) 479-7799
fax: (310) 312-0161
Circle 1081 on Inquiry Card.

Novell's Newest DOS

Novell's DOS 7 offers multitasking, memory management, and peer-to-peer networking. Is it a better DOS than Microsoft's?

TERJE MATHISEN



Most of Novell DOS 7's utilities run under both DOS and Windows. The ND7 Windows group contains icons for backup, virus detection, and network management.

Novell and Microsoft have been sharing our desktop machines for almost a decade. Microsoft supplied the operating system (MS-DOS), while Novell delivered the file and print servers for the same PCs. Then Microsoft went after a bigger share of the networking business, while Novell bought Digital Research and its DOS-compatible operating system.

Novell DOS 7 (ND7) is targeted at existing MS-DOS installations and is intended as a direct replacement for MS-DOS 6.2. ND7 bills itself as a better DOS than MS-DOS, mainly on the strength of a multitasking kernel, better memory management, improved utilities, and a built-in copy of Personal NetWare, Novell's peer-to-peer network operating system. (Of course, however, if Novell really wanted to challenge Microsoft, it could bundle ND7 with NetWare, giving large corporations a single vendor for both PC and server operating systems.) The universal NetWare client software included in the package supports all NetWare servers from version 2.x to 4.0, on almost every network card anyone could want.

The Parts

ND7 consists of three main parts—DOS, Universal NetWare Client, and Personal NetWare—plus a volley of bundled third-party utilities. Its multitasking kernel makes low-overhead DOS multitasking available; the only thing that's needed is TASKMGR.EXE, which uses a scant 3 to 4 KB.

On both 286 and 386 machines, ND7 can use DPMS (DOS Protected Mode Services) to run compliant drivers fully or partly in protected mode. ND7 comes with DPMS versions of disk cache, disk compression, and CD-ROM drivers. The disk cache (NWCACHE) is licensed from Golden Bow systems, while the disk compression is a version of Stac Electronics' Stacker. When you install ND7, Stacker can convert AddStor's SuperStor and Microsoft's DoubleSpace drives on the fly. Stacker's Restack option gives you improved file-compression ratios.

ND7 is bundled with Fastback Express, from Fifth Generation Systems. Both DOS and Windows versions are included. Fifth Generation also supplies the bundled Search & Destroy antivirus package for DOS and Windows.

Installation

I installed ND7 on my main test PC (a Compaq EISA Pentium with 1.5 GB of disk space, 40 MB of RAM, a 21-inch Salora/Nokia low-emission monitor, and an NEC 3X CD-ROM drive). As part of the installation process, ND7 saves away all the necessary information, to make it possible to uninstall later. That's a good idea, but it's where the first problem surfaced.

I use the Norton Utilities NDOS COMMAND.COM replacement. All the current system files are renamed and made read-only and hidden as part of the DOS 7 installation. ND7's installation will also parse the existing CONFIG.SYS file for a SHELL= line and do the same rename operation on whatever file happens to be named there. This would have worked, except that the installation script got too fancy. If SHELL= in CONFIG.SYS points at a replacement for COMMAND.COM, the line is not modified, even though the file itself has been renamed and hidden. When the installation program finished and I was told to reboot to start ND7, I ended up with the error message: `Bad or missing command interpreter; Please enter a valid filename.` I was able to start the system by entering C:\COMMAND.COM, but this is an embarrassing bug for Novell.

Later, to test ND7's Personal NetWare functionality, I used an IBM Model P75 portable. This PC had MS-DOS 5.0 and QEMM 6 installed. When I tried to run A:INSTALL, it started by copying a couple of setup files to drive C and then promptly hung, without any error messages. After rebooting, I simplified my CONFIG.SYS and AUTOEXEC.BAT files as much as possible, loading only HIMEM.SYS and the Norwegian keyboard driver. I still got the same error.

So I then tried to boot directly off the ND7 installation disk. When I did, however, I got a very interesting error message: `BETA DEBUG: TCXL Error`. This looked very much like beta-test code that was left inside the shipping product. It must have been triggered by a bug never expected by the developers and not caught during the beta cycle.

I finally did what I should have done before starting: I read the readme file on the installation disk. The file had a special section about how some portable machines were incompatible with the default enhanced-text mode used by SETUP (and several of the bundled programs). To fix my problem, I could use SETUP /N to run in regular text mode, or, to solve it permanently, I could insert `NewUI=OFF` in SETUP.INI—which is what I did.

continued

FILE-READ PERFORMANCE

Results of timing tests on Personal NetWare. I timed a copy operation of seven files, totaling about 1.5 MB. I copied in both directions between the 25-MHz 486 and the 20-MHz 386, from regular FAT (file allocation table) and compressed Stacker volumes. The speed varies by a factor of 3 from the slowest (386/20 to 486/33) to the fastest (486/33 to 486/25). The most interesting result was that the Cheetah 486/25 gave consistently better results than the IBM 486/33. This must have been due to differences in the network cards and drivers (the Cheetah has a Novell NE2000, and the IBM uses the IBM 16-bit Micro Channel Ethernet Adapter). Results are in KBps.

	CLIENT		
SERVER	486/33	486/25	386/20
486/33	—	233	91
486/25	163	—	96
386/20	84	120	—

Disk Compression

I have an old 20-MHz 386 Toshiba 5200 portable machine, which has its 100-MB hard drive split into two partitions. This machine used DoubleSpace to compress drive D and claimed 10 MB of free disk space. When I installed ND7, DoubleSpace was still autoloaded by the ND7 kernel to support the compressed drive D. I then restarted SETUP, and it offered to convert my DoubleSpace drives to Stacker drives. After about 30 seconds, the system informed me that I didn't "have enough room on drive F to convert all the volumes on it" and that I had to free at least 514,048 bytes by removing files or resizing the DoubleSpace drive.

After restarting the PC, I tried to resize the DoubleSpace drives by running the MS-DOS 6.2 command DBLSPACE /SIZE /RESERVE=514048, whereupon I was told that both the minimum and maximum size of the drive was 67 MB. I then ran DBLSPACE /DEFRAGMENT to pack all the data into the first part of the compressed drive, which would make it possible to resize it. DoubleSpace finished defragmenting the disk after nearly 2 hours, and I then ran DBLSPACE /SIZE again (which took another 15 to 30 minutes).

Finally, I restarted ND7's DoubleSpace-to-Stacker conversion process. Almost immediately, another serious bug surfaced: Stacker refused to perform the conversion process because it could not locate the DOS system files IBMBIO.COM and IBMDOS.COM. MS-DOS 6.2 uses the generic Microsoft names for these files, IO.SYS and MSDOS.SYS, so the IBM version of the filenames could not be found.

To solve this problem, I copied the MS-DOS system files, changing the names to the IBM standard to satisfy Stacker. By using the /H (hidden) option to ND7's XCOPY, I could copy these files without having to remove the ReadOnly, Hidden, and System attributes from them first. Finally, on the fourth attempt, Stacker accepted the drive for conversion. The actual conversion process took all of 11 seconds, after hours of preparation.

Compatibility

By far the most important criterion for an alternative DOS is compatibility. Novell's Desktop Operating System group has done a very good job of polishing up DOS, but there are still a few dings and dents. The first thing I noticed missing was the built-in TRUENAME operation in COMMAND.COM, which has been a documented part of MS-DOS since version 5.0. This command will take any filename or path name and return a canonical version of it. For example, if \BC4\BIN is the current directory on drive D, TRUENAME D: will return D:\BC4\BIN\.

I wrote a test program to see if the supporting DOS API call was available, and it worked, both on local and networked drives. This program, TRUENAME.COM, is just 96 bytes and is available for other ND7 users to download. When I tried TRUENAME.COM on my CD-ROM, TRUENAME E: returned `Cdex.E:\`. This is a serious bug, since many popular programs use this API to parse path names. Most of them will likely choke on the nonstandard return value.

I found another small problem with the CD-ROM: My test machine uses an Adaptec 1740 EISA adapter to support the second hard drive (a 1-GB Hewlett-Packard SCSI-2 drive) and the CD-ROM drive. The Adaptec CD-ROM support software was installed under MS-DOS 6.2 and has worked very well with that version. With ND7, the second of the two drivers gives an error message, "Cannot locate SCSI Manager," but it still loads, and the CD-ROM seems to work just like before.

ND7 apparently emulates the (partly) undocumented internal DOS structures very well, masquerading as MS-DOS 6.x. The emulation is good enough that Microsoft Diagnostic (MSD.EXE) is fooled, but some of the information shown in MSD, particularly the UMB (Upper Memory Block) display, is obviously wrong. This suggests that ND7 uses a different scheme to manage these blocks, but the UMB APIs work well enough that a program I wrote a couple of years ago that relocates itself into a UMB worked perfectly without any modifications.

Windows Compatibility

When I first installed ND7, I had Windows for Workgroups 3.11 installed on my PC—not because of the peer-to-peer networking functions (which I don't use), but because WFW has better performance than Windows 3.1, particularly due to 32-bit file and disk access. ND7 did not complain about running WFW, and everything seemed to work OK as long as I was using Windows programs or working on a local drive.

After a couple of hours, I needed to update an old Pascal program, so I started Borland's Turbo Pascal (BP7) inside a DOS box. The source code was in my default directory on a NetWare 4.01 server. It loaded fine, and it found all the files I had been working on last. I made a few changes and pressed the F9 key to rebuild the program. At this point, BP7 complained about not finding any files.

After snooping around, I found that the problem is located in the Get and Set Current Directory functions (INT 21, functions 47h and 3Bh). With WFW loaded, I consistently ended up at the root of the network drive (I:\) instead of at my source directory (I:\BP\SRC). When I reinstalled Windows 3.1 instead of WFW, the problems disappeared.

To test Win32s compatibility, I installed the Win32s support code, which consists mostly of VxDs (virtual device drivers). This code ran without a glitch, and all the demonstration programs from the Windows NT SDK (Software Development Kit) CD-ROM that I tried ran without any problems.

The only consistent problem I found in the Windows 3.1 support was with a few utility programs written in Borland Pascal and quickly converted to run inside Windows by using Borland's WinCRT unit. These programs run well under Windows 3.1, WFW, and NT, but after ND7 is installed, the system complains about a

General Protection Fault and aborts the program. I have a suspicion that this might be related to the DPMI (DOS Protected Mode Interface) support in ND7, since I get exactly the same error messages when I try to run these programs under OS/2 2.1.

Personal NetWare

The last component of the ND7 package is a bundled copy of Novell's peer-to-peer network product, Personal NetWare. To use it, at least one PC must be designated as a server and make some of its resources available for sharing on the network. PCs that act only as clients can use the Universal Client to access both NetWare servers and Personal NetWare servers.

I first installed Personal NetWare on the 20-MHz 386 Toshiba portable. This almost worked, except that the SETUP program modified my existing (working) NET.CFG configuration file and substituted the default parameters for my network card. When I next rebooted, the adapter driver declined to load. I had to locate the problem manually, edit the NET.CFG entries back to the proper values, and reboot. It is a good idea to make a copy of your NET.CFG before you let ND7 mess around with it.

Personal NetWare comes with Novell's new Universal Client software, based on the VLM (virtual loadable module) technology developed for Novell's high-end NetWare 4.01. With a single installation, the new VLM driver set lets a PC access both Personal NetWare servers and all the versions of dedicated NetWare servers (from 2.2 to 4.01), and it uses less low memory than the old-style NETX driver.

I have measured extremely high performance on both Ethernet and 16-Mb Token Ring using these drivers to access a NetWare 4.01 server—1.03-MBps sustained throughput for a single connection doing large reads on Ethernet and 1.76-MBps on Token Ring—so I was curious about the performance offered by Personal NetWare. The network software's performance was adequate, but it was a large step below what you can get from a dedicated NetWare 3.11 or 4.01 server. The "File-Read Performance" table on page 242 gives you some idea of what I found.

For a small workgroup like the one in my home, the most critical criterion is how much the foreground task on a peer server is affected by background activity. When my son Fredrik wanted to play Lemmings 2 on the 25-MHz 486, I started the game for him and then started to copy big files to and from the 486. The little animated lemmings in the game just kept moving, without any delays or stutters.

Multitasking

Task-switching support is built in, starting with a multitasking kernel that supports programs written for the old Multiuser DR DOS. The memory manager, EMM386.EXE, also supports multitasking, with a MULTI option on the command line. According to the manual, this even makes it possible to multitask protected-mode DOS programs.

To test this capability, I loaded the Borland Pascal environment in one session and then used the protected-mode version of Turbo Assembler, TASMX, to assemble a program in another session. This immediately blew up, giving me a full-screen version of the infamous General Protection Fault message. I shouldn't have expected anything else, really, since the same

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FRACTAL COMPRESSION

thing happens in a Windows DOS machine and under OS/2 2.1. I was able to successfully run Borland C++ 3.1, which uses another non-DPMI-compliant DOS extender. This program does not run under OS/2, but it worked OK with TASKMGR.

TASKMGR works like Windows Enhanced Mode or OS/2 by creating V86 (virtual 8086) machines, giving each session the illusion that it has its own CPU. This means that TASKMGR, in cooperation with EMM386, must act as the V86 monitor, intercepting all hardware interrupts in protected mode and redirecting them to the current DOS program, which then handles them as if in real mode.

In theory, this should all work well, but since the redirection uses quite a few cycles, it can mess up time-critical operations. In OS/2 and Windows, this particular problem is fixed by writing protected-mode handlers for things like keyboard, mouse, and serial communications. These drivers then virtualize the hardware on behalf of the DOS programs, fooling them into believing that they have direct hardware access.

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On my hardware, the mouse worked perfectly well in multiple loaded programs. Communication was another matter, however: I had to step down to 19.2 Kbps to keep a file transfer running in the background, and the effective baud rate dropped to about 1.4 Kbps.

I use my machines mainly for software development, working in a DOS environment. I liked ND7's approach to multitasking since it made it easy for me to start a new session at any time to test out a new program or look up an on-line reference.

The DOS Dilemma

ND7 is an impressive package that could have used a more thorough beta testing before release. Most of the problems I found were minor, but they could have been eliminated completely. If nothing else, Novell's continued development of Novell DOS should keep Microsoft on its toes.

ND7 makes the most sense for companies that are already using Digital Research's old Concurrent DOS, as well as for companies that need many of the bundled features. For Windows-only users, Personal NetWare has to compete with Windows for Workgroups, which gives roughly the same feature mix but keeps all the networking software in protected mode, out of the DOS arena. I'm planning to keep Novell DOS 7 installed on my home machines, but for the office PC, I'll wait for a bug-fix release that solves the CD-ROM problems. ■

Editor's note: *TRUENAME.COM is available electronically. See page 5 for details.*

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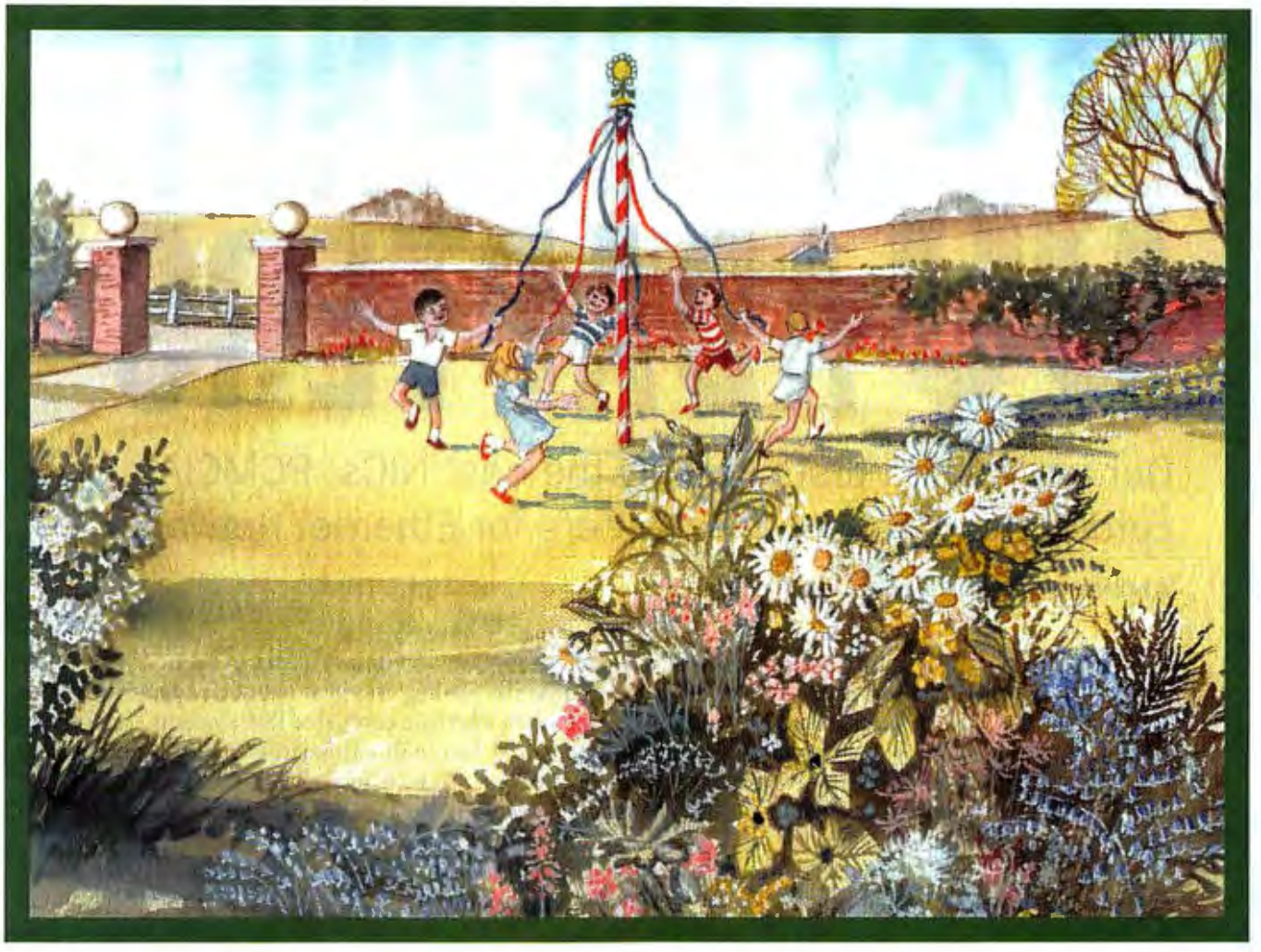


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66 ETHERNET ADAPTERS

Our application tests identify the best NICs, PCMCIA cards, and parallel-port adapters for Ethernet networks

ANTHONY J. LENNON

Whether you're setting up an Ethernet client workstation or just trying to connect your notebook to an in-house LAN, here's a guide for finding the best network adapter for your needs. We examined 35 16-bit NICs (network interface cards) for ISA systems, 15 portable adapters that connect via a parallel port, and 16 credit-card-size PCMCIA cards. Using our application benchmarks, we ranked the best products in each technology class for both speed and how easily each can be installed and used on a network. Our tests focused on Ethernet because it is the most popular networking scheme.

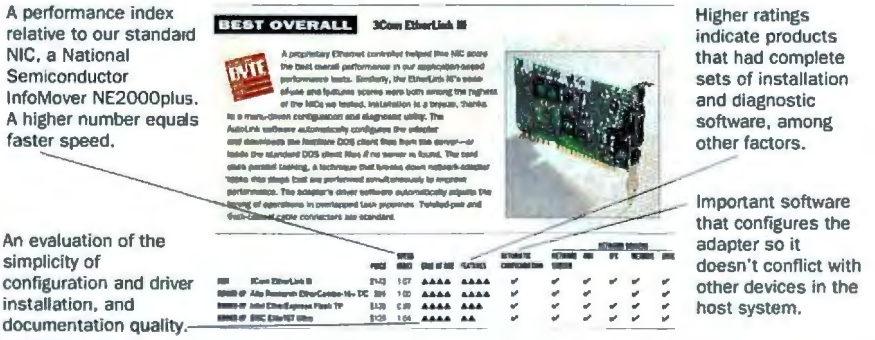
Standard 16-bit NICs, the best solution for desktop client workstations, are mature products. Their prices continue to fall, and installation problems centered around tedious jumper and DIP-switch settings are becoming a thing of the past (see "The Best 16-bit NICs" on page 248). Compared to their portable counterparts, NICs cost less (by an average of $135), but each NIC is tied to one desktop unit.

PCMCIA adapters are relatively expensive ($257 on average), but they are the ideal solution for mobile systems that have PCMCIA Type II slots. We found that installation and compatibility problems are a rarity if C&S (Card and Socket Services) software is installed on the host and if only one PCMCIA card is installed (see "The Best PCMCIA Cards" on page 252).

The major benefit of parallel-port adapters is that they can be installed in just seconds on either desktop or mobile systems. Pocket adapters are self-configuring. With EPP (Enhanced Parallel Port) support, these adapters cost the same on average as their PCMCIA counterparts, but they cannot match their speed: In our suite of tests, the PCMCIA adapters outperformed the portable adapters (in EPP mode) by an average of 11 percent.

How to use this guide

To find the best network adapter for your needs, follow the main headings until you come to the appropriate hardware category (i.e., 16-bit ISA, PCMCIA, or portable). Then look at the summary charts (like the example below) to find our choices for the best overall and the best low-cost adapters. We selected adapters by choosing the ones with the best mix of performance, features, usability, and, for the low-cost category, price.



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Essential Elements

Portable Adapters

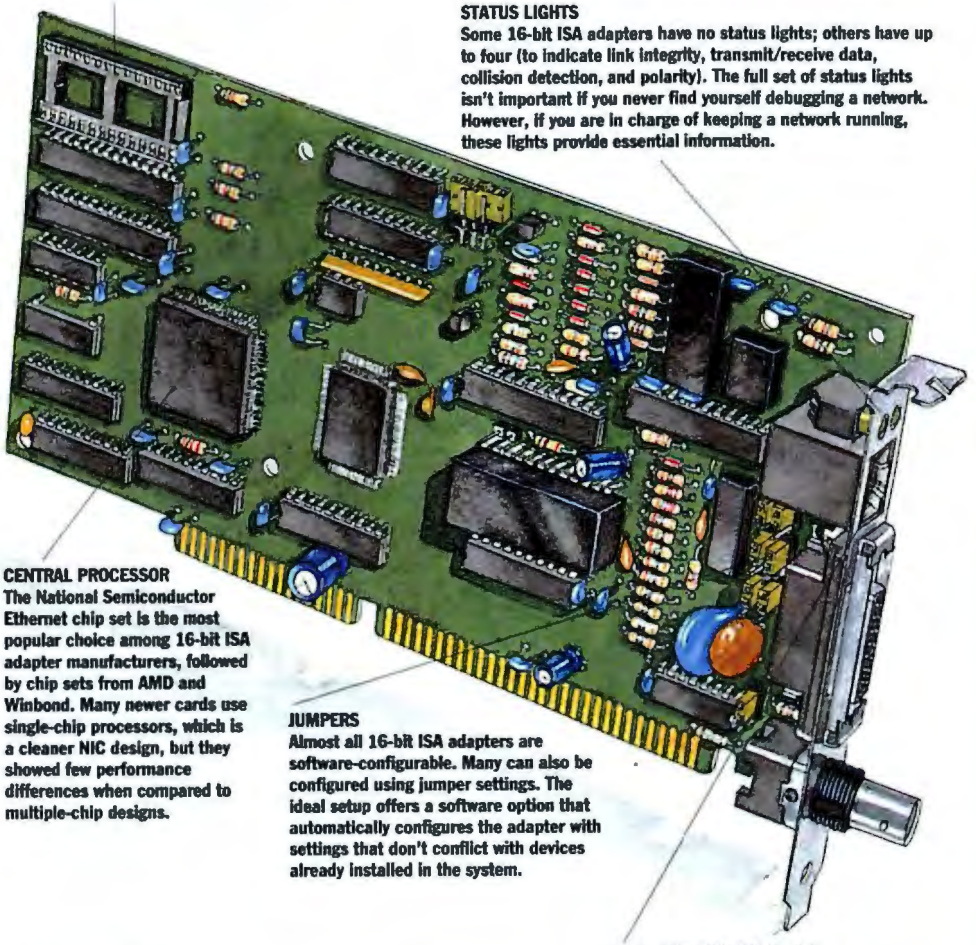
EPP SUPPORT
For fastest speed, choose adapters that offer EPP (Enhanced Parallel Port) support. These adapters offer throughput levels that are as much as 50 percent higher than those for adapters with only unidirectional support, although prices for EPP products average about $100 more.



Network Interface Cards

BOOT-ROM SOCKET
With a boot ROM, you can boot a diskless DOS workstation from a network. Keeping DOS and all your software on the network makes software maintenance a lot easier, but it places a heavier load on the server.

STATUS LIGHTS
Some 16-bit ISA adapters have no status lights; others have up to four (to indicate link integrity, transmit/receive data, collision detection, and polarity). The full set of status lights isn't important if you never find yourself debugging a network. However, if you are in charge of keeping a network running, these lights provide essential information.



CENTRAL PROCESSOR
The National Semiconductor Ethernet chip set is the most popular choice among 16-bit ISA adapter manufacturers, followed by chip sets from AMD and Winbond. Many newer cards use single-chip processors, which is a cleaner NIC design, but they showed few performance differences when compared to multiple-chip designs.

JUMPERS
Almost all 16-bit ISA adapters are software-configurable. Many can also be configured using jumper settings. The ideal setup offers a software option that automatically configures the adapter with settings that don't conflict with devices already installed in the system.

RJ-45, BNC, AND AUI PORTS
Most networks use either UTP (unshielded twisted-pair) or coaxial (thin Ethernet) cabling. These cabling schemes can be mixed, since most UTP hubs have a coaxial connection. Buying a NIC with both RJ-45 and BNC connectors will allow you future flexibility. A third type of connector—AUI, or thick Ethernet—is available on many cards.

PCMCIA Cards

LEDS
Clear status lights are essential for fast diagnosis of network problems.



MEDIA ACCESS MODULE (MAM)
For easiest installation, look for modules that can plug directly into an Ethernet hub. The adapters in our test sample from Boca, CNet, 3Com, and Xircom offered this feature.

JUNE 1994 BYTE BEST NETWORK HARDWARE

BEST

16-BIT NIC

3Com EtherLink III

The top performer in our application-based benchmarks, this 16-bit NIC uses parallel tasking to shorten the data transfer cycle with predictive interrupts and pipelining. Its AutoLink software automatically configures the adapter and loads the appropriate network client software. The EtherLink III supports twisted-pair and thick coaxial cabling.

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PCMCIA CARD

3Com EtherLink III PCMCIA

Like its NIC cousin, this adapter uses pipelining to improve packet-processing speed and provide the best performance in its class. The installation software automatically configures the card and loads the necessary files to configure the host system as a NetWare DOS ODI (Open Data-Link Interface) client. Comprehensive diagnostic utilities and an LED indicator on the card aid in diagnosing network problems.

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PORTABLE ADAPTER

Compex Para Port-E

The Compex Para Port-E offers EPP support and one of the fastest performance scores for this group. The adapter draws power from the host's keyboard connector (an external AC adapter is optional) and includes a printer pass-through port. Four LEDs for diagnosing network problems are provided, along with BNC and RJ-45 connectors. The NetWare ODI driver automatically sets the adapter to the highest performance mode supported by the host's parallel port.

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ILLUSTRATIONS: BRUCE SANDERS © 1994

THE BEST

16-BIT NICS

Prices for 16-bit ISA Ethernet NICs average $147 less than PCMCIA adapters and $129 less than parallel-port adapters, and NIC prices continue to drop. For example, the NICs in this report, which cost an average of $110, average $60 less than those in our August 1993 Lab Report (see "Network Connections: 100 Ethernet Cards"). At the same time, vendors have improved reliability through enhanced chip integration. As a result, almost a third of the NICs in this review carry lifetime warranties, compared to only 15 percent of the adapters in the August Lab Report.

As a group, NICs are becoming easier than ever to install and use. For example, a minority of the cards we tested last year were software-configurable, while all the NICs in this roundup offer this capability. (Note, however, that the GVC NIC-2003BT uses software to configure the emulation mode only; you must change other settings through hardware.) Almost half of the NICs in this report—and all the NICs ranked as best overall—come with automatic-configuration software. By contrast, only the top three low-cost cards offer this feature.

As in our last network-hardware report, we found NIC performance to be relatively uniform. For example, the difference between the fastest and the slowest NIC ranked as best overall was only 8 percent. So a database file that took 12.5 seconds to load from a network when using the fastest card would take only 1 second longer with the slower NIC.

While the 3Com EtherLink III offers the best mix of performance, ease of use, and features, the cards we've ranked as runners-up are also solid performers. The second-ranked Alta EtherCombo-16+ T/C ran only 7 percent slower than the top-ranked EtherLink III. In addition, the EtherCombo comes with Novell NetWare, Unix, and NDIS boot ROMs; SMC/Western Digital and NE2000 emulation; and four LEDs for diagnosing network problems. Alta also includes a diagnostic utility that lets you view packets on the network, similar to the way that a LAN analyzer displays packets.

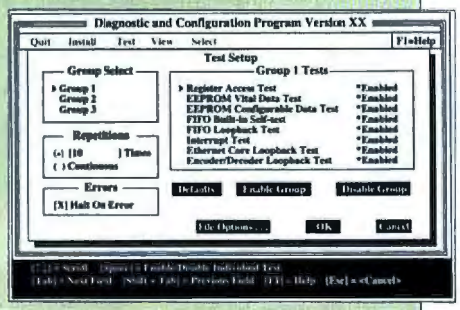
Intel's third-ranked EtherExpress Flash TP comes bundled with several utilities for network administrators. A FlashStart program, stored in a flash-memory chip, automatically loads after you power up the system. The program can configure the adapter and download drivers from the file server. The flash-memory chip also comes with boot programs for NetWare or Microsoft

HASSLE-FREE NICS

For simplicity in ease of installation and use, choose a NIC with the following features (see the Roll Call on pages 260 through 263 for details on individual products):

Configuration Software

Utilities that automatically configure a NIC for the host system are ideal; nearly half of the NICs in this review can be configured automatically. The software alters configuration settings such as the base I/O address, IRQ (interrupt request) setting, DMA channel, and RAM address, which eliminates the need for tedious jumper and DIP-switch hardware. Moreover, you can quickly modify a board's configuration without having to open up the system to access NIC switches.



Diagnostic Software

All but two of the NICs reviewed here offer some type of software bundle to help you troubleshoot network problems. The best packages include diagnostics for loopback and interstation transmission testing, plus the ability to gather statistics on frame overruns and collisions.

Network Drivers

NICs should provide multiple drivers to support your current needs (e.g., Novell NetWare server, ODI, IPX, NDIS, NetBIOS, and Unix) as well as network operating systems you may add in the future (e.g., NetWare clients for Windows NT).

Boot ROMs

Boot ROMs allow diskless workstations to attach to a network. Our evaluations gave the highest marks to NICs that offered boot ROMs for at least two different network operating systems.

Status Lights

LED indicators for items such as packet transmit/receive, link integrity, and collision detection help you to diagnose problems quickly.

Documentation

Finally, don't overlook the quality of the manuals that come with a NIC. Clear instructions for installing the adapter and its drivers save you time. In our evaluations, we also placed importance on the presence of a glossary and whether technical-support information was easily accessible.

LAN Manager, so you don't need to purchase and install separate boot ROMs on diskless workstations.

A second utility allows the network administrator to update drivers centrally on the file server. Each workstation on the network receives the updated files when users log on.

The Standard Microsystems Elite16T Ultra includes a two-node utility that tests the adapter's ability to communicate over a network with another adapter. Racal InterLan provides a number of internal and network diagnostic tests for its EtherBlaster TP adapter, and Allied Telesis's CardAssistant diagnostic routine tests the AT-1500BT Plus adapter and its configuration for functional problems or conflicts with other installed devices.

The Elite16T Ultra uses a proprietary Ethernet controller and provides slightly better overall performance than the AT-1500BT Plus and the EtherBlaster TP, which use AMD Ethernet controllers.



In the low-cost (under $90) category, the winning Longshine LCS-8634L-TBA and runner-up Kingston EtheRx 2000 Plus Triple Interface have documentation that lacks technical-support information, but the manuals are clearly written and contain numerous charts and diagrams. The CeLAN E2000C's documentation is a single sheet of paper that lists jumper settings and available network drivers. But the E2000C is the only card in this group with a lifetime warranty. The three top NICs can be automatically configured, unlike the remaining three adapters in this category.

KEY

Poor ▲ Fair ▲▲

Good ▲▲▲ Excellent ▲▲▲▲

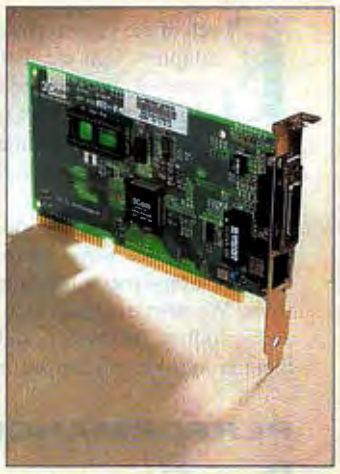
Yes = ✔

For speed and easy configuration...

BEST OVERALL — 3Com EtherLink III



A proprietary Ethernet controller helped this NIC score the best overall performance in our application-based performance tests. Similarly, the EtherLink III's ease-of-use and features scores were both among the highest of the NICs we tested. Installation is a breeze, thanks to a menu-driven configuration and diagnostic utility. The AutoLink software automatically configures the adapter and downloads the NetWare DOS client files from the server—or loads the standard DOS client files if no server is found. The card uses parallel tasking, a technique that breaks down network-adapter tasks into steps that are performed simultaneously to improve performance. The adapter's driver software automatically adjusts the timing of operations in overlapped task pipelines. Twisted-pair and thick-coaxial cable connectors are standard. The EtherLink's documentation stands out for its clarity and comprehensiveness. It comes with a glossary, a detailed index, and numerous diagrams. Note: This card supports 3Com emulation, but not NE2000 or SMC/Western Digital emulation.



		PRICE	SPEED INDEX	EASE OF USE	FEATURES	AUTOMATIC CONFIGURATION	NETWORK DRIVERS: NETWARE SERVER	ODI	IPX	NETBIOS	UNIX
BEST	3Com EtherLink III	$143	1.07	▲▲▲▲	▲▲▲▲	✔	✔	✔	✔	✔	✔
RUNNER-UP	Alta Research EtherCombo-16+ T/C	$99	1.00	▲▲▲▲	▲▲▲▲	✔	✔	✔		✔	✔
RUNNER-UP	Intel EtherExpress Flash TP	$139	0.99	▲▲▲▲	▲▲▲	✔	✔	✔	✔	✔	✔
RUNNER-UP	SMC Elite16T Ultra	$129	1.04	▲▲▲▲	▲▲	✔	✔	✔	✔	✔	✔
RUNNER-UP	Compex ENet 16 Combo/VP	$99	1.01	▲▲▲▲	▲▲▲	✔	✔	✔	✔		
RUNNER-UP	Allied Telesis AT-1500BT Plus	$100	1.03	▲▲▲▲	▲▲▲	✔	✔	✔		✔	✔
RUNNER-UP	Thomas-Conrad TC5143-T	$98	1.00	▲▲▲▲	▲▲▲▲	✔	✔	✔	✔	✔	✔
RUNNER-UP	Racal InterLan EtherBlaster TP	$159	1.02	▲▲▲▲	▲▲▲	✔	✔	✔	✔	✔	✔

Budget-conscious?

LOW COST — Longshine LCS-8634L-TBA



The performance of this NIC's proprietary LSIC905R Ethernet controller is comparable to that of most of the boards ranked for best overall. This combination board supports twisted-pair, thick-coaxial, and thin-coaxial cabling, and it automatically detects the connection type. All settings are automatically configured by software that detects available system resources. This NIC supports NE2000 and SMC/Western Digital emulation, but not 3Com emulation.

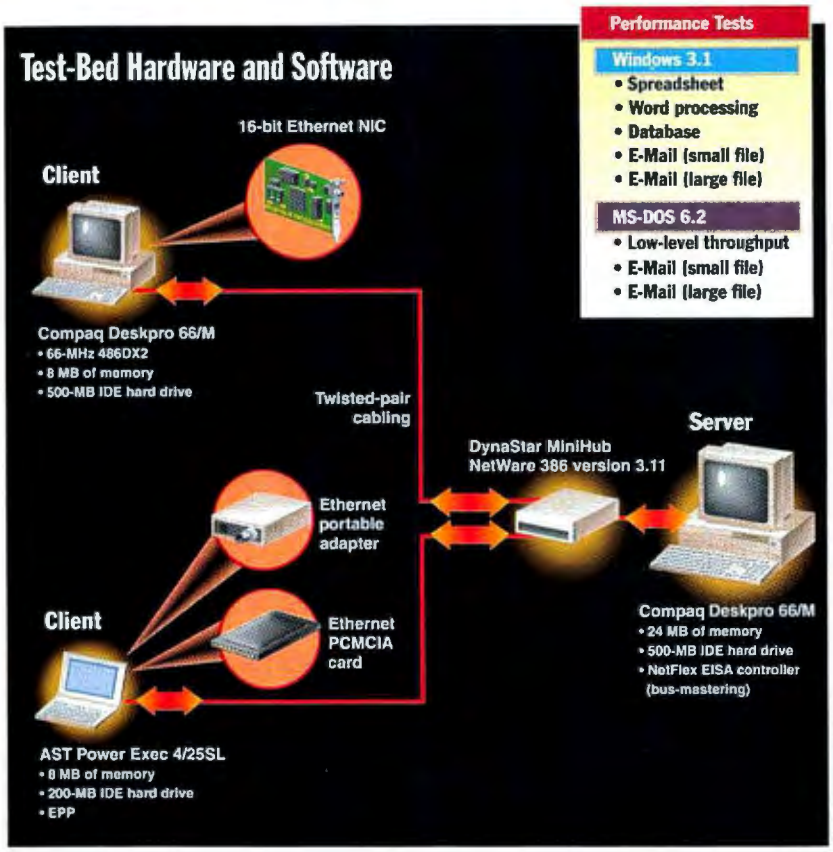
Also noteworthy is the $45 Elisa ETI-LAN002TLC, which offers essentially the same performance as the top-ranked Longshine LCS-8634L-TBA. It provides twisted-pair, AUI (attachment unit interface), and BNC connectors; supports NE2000 emulation; and is backed by a 5-year warranty. We ranked it fourth, however, because it doesn't offer automatic configuration, and its documentation is sparse and doesn't present clear setup instructions.

		PRICE	SPEED INDEX	EASE OF USE	FEATURES	AUTOMATIC CONFIGURATION	NETWORK DRIVERS: NETWARE SERVER	ODI	IPX	NETBIOS	UNIX
BEST	Longshine LCS-8634L-TBA	$79	1.01	▲▲▲▲	▲▲▲	✔	✔	✔	✔		✔
RUNNER-UP	CeLAN Technology E2000C	$89	1.01	▲▲▲	▲▲▲	✔	✔	✔	✔	✔	✔
RUNNER-UP	Kingston EtheRx 2000 Plus	$89	0.97	▲▲▲▲	▲▲	✔	✔	✔			
RUNNER-UP	Elisa Technology ETI-LAN002TLC	$45	1.00	▲▲	▲▲▲▲		✔	✔	✔		✔
RUNNER-UP	Lancast 4116 Combo Card	$79	1.00	▲▲	▲▲▲▲		✔	✔	✔		✔
RUNNER-UP	SVEC FD0490I	$69	0.99	▲▲	▲▲▲		✔	✔	✔		✔

How We Tested

Each of the three types of network adapters that we tested had to supply UTP (unshielded twisted-pair) connectors (some also included BNC and AUI connectors) and directly support Novell NetWare 386 version 3.11.

Our NIC suite consisted of 18 data transfer tests that simulated a variety of network-usage patterns and load conditions. We also evaluated the design of each product, its drivers, and its documentation to determine our rankings.



PERFORMANCE

Our test-bed server was a Compaq Deskpro 66/M (see the illustration). The server's and NetFlex controller's memory creates a large buffer to minimize the server's effects on client/server performance. We designed all tests so that there was a minimum of disk usage on the server, since frequent disk access could lower throughput and mask the performance of the adapter being tested. Additional test equipment included a diskless 286-based workstation with 1 MB of memory, to generate network traffic, and a DynaStar MiniHub.

We used NetWare 386 version 3.11 drivers supplied by each network-hardware vendor. We also used monolithic drivers for the 16-bit NICs if they were provided. We tested PCMCIA cards and portable adapters with ODI (Open Data-Link Interface) drivers, which reflects common usage. We tested the portable adapters in unidirectional mode and in the fastest mode that each one supported (i.e., bidirectional or EPP).

APPLICATION TESTS

We created the spreadsheet test by replicating the file-system access of Microsoft Excel 4.0. Each call, including the file, location in the file, and size of the operation, was re-created in detail for the reading and writing of small (20 KB) and large (100 KB) spreadsheets. We created the word processing test in a similar fashion by replicating the file-system operations of WordPerfect for Windows 5.1.

We designed two tests using cc:Mail for Windows. Each is an actual cc:Mail application, which sends a message with an attached file to a specified user. One test attaches a small representative text file, while the other attaches a larger spreadsheet. Two similar tests run on DOS. The last Windows test was an application that reads and writes an indexed database.

Once we compiled our transaction-per-minute data, we computed a speed index relative to the performance of the 16-bit ISA-based National Semiconductor InfoMover NE2000plus.

The performance of the 16-bit ISA adapters cannot be directly compared to that of the PCMCIA and portable adapters because they are tested on different client workstations. Also, the NIC scores presented here aren't directly comparable to those from the August 1993 Lab Report because we used a different client workstation in our test-bed. This Lab Report also presents speed in a simplified index format rather than in transactions per minute.

USABILITY

We awarded points to products according to the number of features that they provided from our list of essential features (see the text box "Hassle-Free NICs" on page 248). The portable adapters that received the highest features scores offered both bidirectional and EPP support, the ability to draw power from an external mouse or keyboard port, and a parallel port pass-through that enables you to simultaneously attach a printer and a NIC.

We assessed three areas for our ease-of-use ratings: configuration of the adapter, installation of the network drivers, and quality of the technical manual.

Contributors

Alan Joch, *Senior Editor/BYTE, coordinates the combined testing between the BYTE Lab and NSTL.*

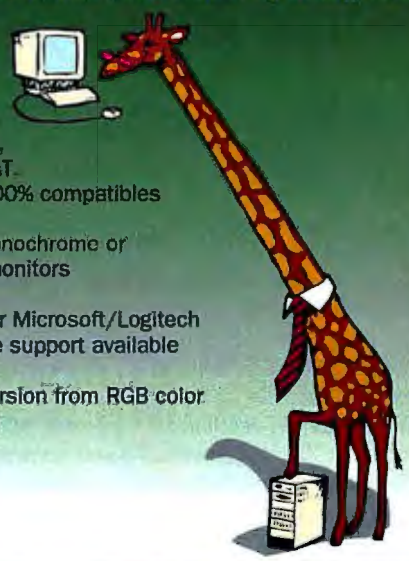
Siva Kumar, *Technical Analyst/NSTL, specializes in hardware and network-operating-systems testing.*

Anthony J. Lennon, *Project Manager/NSTL, evaluates servers and network hardware, as well as portable systems and peripherals.*

The Lab Report is an ongoing collaborative project between BYTE magazine and National Software Testing Laboratories (NSTL). BYTE magazine and NSTL are both operating units of McGraw-Hill, Inc. Contact the NSTL staff on the Internet at editors@nstl.com; at NSTL, Inc., Plymouth Corporate Center, Plymouth Meeting, PA 19462; or at (610) 941-9600. Contact BYTE on the Internet or BIX at ajoch@bix.com or at (603) 924-9281.

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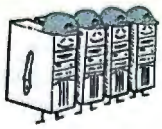


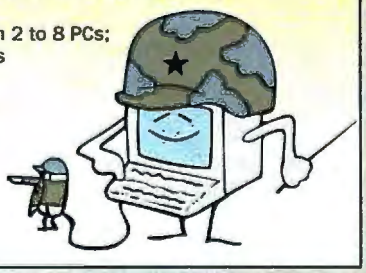
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Circle 82 on Inquiry Card (RESELLERS: 83).

THE BEST

PCMCIA CARDS

PCMCIA support by portable computers is becoming universal. For example, in our March Lab Report (see "46 Powerful Portables"), 83 percent of the 486-based notebooks and subnotebooks we reviewed contained at least one PCMCIA slot. In addition, internal and external PCMCIA-card readers are also available for desktop systems.

The cards that we tested here conform to the PCMCIA release 2.01 Type II standard and to the IEEE 802.3 Ethernet standard; they conform to the standard dimensions of 2.16 by 1.35 by 1.3 inches. The cards are all software-configurable and draw their power from the client system, so they do not use external AC adapters.

In the mobile market, these cards compete directly against parallel-port Ethernet adapters. The average price for a PCMCIA Ethernet adapter is $257, which is also the average price for a portable Ethernet adapter with EPP support. In our overall tests, the PCMCIA adapters outperformed the portable adapters in EPP mode by an average of 11 percent.

However, we found that the performance advantage of PCMCIA adapters was somewhat application-dependent. For instance, they outperformed the parallel-port adapters by about 15 percent in our spreadsheet benchmarks but posted only a 4 percent advantage in the cc:Mail for Windows tests, which tend to be more processor-intensive.

We saw less than a 7 percent difference between the fastest and the slowest PCMCIA adapters (the 3Com EtherLink III PCMCIA and Xircom's CreditCard Ethernet Adapter, respectively). Consequently, ease of configuration and features largely determined our overall rankings.

These PCMCIA adapters typically come with MAMs (media-access modules), which connect the cards to the physical network. The Boca, CNet, 3Com, and Xircom adapters we tested do not require external modules for 10Base-T connections because they can plug directly into an Ethernet hub. The Accton Ethernet PCMCIA Card's MAM comes with both 10Base-T and 10Base-2 connectors, and it automatically identifies the proper cable type.

Status lights can be very useful in diagnosing network problems. Typically LEDs, they provide link-status information and show whether data is being transmitted over the wire. All but two of the PCMCIA adapters in this review have at least two LEDs (either on the MAM or on the card itself) for showing both link-status information and whether data is being transmitted over the wire. The exceptions are 3Com's EtherLink III PCMCIA, which has only one LED, and the Boca PCMCIA 10Base-T Ethernet Adapter, which does not contain any status lights. However, neither model was hampered by its design: Both received ease-of-use ratings of excellent.

Whether or not C&S (Card and Socket Services) is present on a client system largely determines how easy a PCMCIA adapter is to use and install. Socket Services is hardware-dependent software that monitors each PCMCIA slot in a system to determine if a card is present. Card Services is a hardware-independent software management interface that controls communications between the PCMCIA card and the system. It makes system resources (e.g., IRQ [interrupt request], I/O port, and base-memory address) available to the adapter and dynamically allocates the resources when you load the NetWare DOS ODI (Open Data-Link Interface) driver.

The PCMCIA adapters from Ansel, Kingston, Microdyne, and National Semiconductor ship with their own C&S drivers (along with resource-table management software). The Boca PCMCIA 10Base-T Ethernet Adapter comes with its own C&S software, while the Black Box PCMCIA Ethernet Adapter 10BT ships with a device driver that automatically

UNIVERSAL C&S

Most PCMCIA Ethernet card vendors provide their own C&S software with their adapter or include enabler drivers that let the card function in the absence of C&S. The problem with using enabler drivers is that they are typically designed by the vendor to get its particular PCMCIA card to function, which is of little help if you want to install multiple PCMCIA adapters. Some vendors, including CNet, simply refer you to your system vendor for C&S software.

Versa Technology has developed a third-party PCMCIA driver—CCMSTR.SYS version 2.06—that provides C&S for systems that lack these resources. The driver will automatically assign the next available memory and IRQ setting for Ethernet adapters when default settings conflict. This functionality is not available with token-ring NICs; their default settings must be changed via setup software. An advantage of the driver is that it requires only 24 KB of memory (versus the 53 KB required for typical C&S drivers).

CCMSTR.SYS loads into memory when you boot the host system. The driver supports PCMCIA's hot-removal and insertion feature. However, the driver does not support the hot removal of a card after Novell NetWare network drivers have been loaded. A pop-up window displays the type of PCMCIA card present, its IRQ level, and I/O and memory addresses.

We tested the CCMSTR.SYS driver on the CNet CN10BT and the Xircom CreditCard Ethernet Adapter, and it experienced no problems.

Versa Technology is planning to bundle the CCMSTR.SYS driver with a desktop card reader that is now under development. The primary market for the driver is system vendors and OEMs, but a BBS from which to download the driver will be available. The driver supports PCMCIA versions 1.0 through 2.1, and Versa Technology can supply a list of PCMCIA devices that have been successfully tested with its driver. Contact the company at (714) 533-6668.



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[800]

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Circle 102 on Inquiry Card (RESELLERS: 103).

At $345 it doesn't pay to buy dumb.



New Compex TP3000 manageable 6-port hub.

Dumb hubs are, well, pretty dumb. But intelligent hubs cost too much. Now there's an alternative. New Compex TP3000™ modular, manageable 6-port hub system.

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TP3000 hubs stack in groups of four.

Basically, with a TP3000 system a network can start small and then grow indefinitely. Two ports at the back of the compact unit let you daisy chain the hub. Six RJ45 connectors and status LEDs are located on the front. One coax connector allows you to easily connect 10 Base T workstations to existing coax networks. Unlike other hubs, the TP3000 doesn't use data ports for expansion, so all ports are available for node connection.

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COMPEX

Out-connecting the rest

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Circle 74 on Inquiry Card (RESELLERS: 75).

allocates system resources if C&S is present.

Compex, IBM, and Thomas-Conrad supply enabler software drivers for use with their PCMCIA adapters. An enabler is a device driver that resides in CONFIG.SYS or AUTOEXEC.BAT and accepts configuration parameters (e.g., IRQ, base I/O, and memory address). Enabler drivers can also take over if your system does not support C&S drivers provided by a peripherals vendor. But enablers can limit the functionality of the PCMCIA card. For instance, you must insert the adapter during driver initialization, and there is no card insertion/removal support after you have booted up the system. In addition, you can make changes to the adapter's default settings only in the NET.CFG file for NetWare DOS ODI workstations (or in the PROTOCOL.INI file for NDIS drivers).

The driver software that is included with the CLI IC-Card T and the Addtron EP-200T PCMCIA cards automatically configures the adapters for you as long as C&S is present. The host automatically detects the available resources and then allocates them for use by the network adapter.



While we were testing C&S drivers and enablers or the Versa Technology driver (see the accompanying text box on page 252), we didn't encounter any compatibility problems with our testbed notebook. However, our tests didn't include running multiple PCMCIA cards in a single system, and incompatibilities can possibly arise when you are using cards with different drivers.

KEY

Poor ▲ Fair ▲▲
Good ▲▲▲ Excellent ▲▲▲▲
Yes = ✔

BYTE BEST — PCMCIA CARDS

For problem-free PCMCIA installation...

BEST OVERALL — 3Com EtherLink III PCMCIA





This card, which uses a proprietary controller, scored the best overall performance in our benchmarks. It comes with BNC and twisted-pair couplers that can be inserted only in their proper orientation. The EtherLink III PCMCIA received an ease-of-use rating of excellent thanks to its clear and comprehensive documentation and an installation program that automatically configures the card and loads the files necessary for it to function as a NetWare DOS ODI client. The EtherLink III is not designed to communicate with Card Services; its driver directly programs the PCMCIA controller in the client to configure the PCMCIA card. (To avoid conflicts, 3Com recommends that C&S not be installed unless it's required by another PCMCIA adapter.)

Also worth noting are the first and second runners-up from Thomas-Conrad and National Semiconductor. Each sells for a price near that of the 3Com adapter and offers performance that's a negligible 3 percent slower than that of the leader. The second-place Thomas-Conrad card ships with an enabler software driver. The National Semiconductor adapter offers a C&S software driver.

		PRICE	SPEED INDEX	EASE OF USE	FEATURES	NETWORK DRIVERS: NETWARE SERVER	ODI	IPX	NETBIOS	UNIX
BEST	3Com EtherLink III PCMCIA	$225	0.60	▲▲▲▲	▲▲▲▲		✔		✔	
RUNNER-UP	Thomas-Conrad TC5041-T	$230	0.58	▲▲▲▲	▲▲▲▲		✔			✔
RUNNER-UP	National Semiconductor InfoMover NE4100	$213	0.58	▲▲▲▲	▲▲▲▲		✔	✔		
RUNNER-UP	Xircom CreditCard Ethernet Adapter	$299	0.56	▲▲▲▲	▲▲▲▲		✔		✔	
RUNNER-UP	Alta Research EtherMCIA UTP	$299	0.58	▲▲▲▲	▲▲▲▲	✔	✔		✔	
RUNNER-UP	Accton Ethernet PCMCIA Card	$199	0.57	▲▲▲▲	▲▲▲▲	✔	✔	✔	✔	✔
RUNNER-UP	Microdyne NE4000T	$249	0.58	▲▲▲▲	▲▲▲		✔			
RUNNER-UP	Kingston EtheRx PCMCIA Adapter	$179	0.58	▲▲▲▲	▲▲		✔			
RUNNER-UP	CLI IC-Card T	$395	0.57	▲▲▲▲	▲▲▲	✔	✔	✔	✔	
RUNNER-UP	IBM Credit Card Adapter	$225	0.58	▲▲▲	▲▲▲		✔	✔	✔	

Is $200 your limit?

LOW COST — Accton Ethernet PCMCIA Card



This under-$200 card provides overall performance that's on a par with that of PCMCIA adapters that cost $100 more. The adapter's media coupler includes both 10Base-T and 10Base-2 connectors. The card automatically detects the type of wiring in use, and an enabler program automatically loads in the system's configuration to allow the card to function in computers that do not include C&S. An installation utility helps you select hardware settings and copies the appropriate network drivers to a selected subdirectory. The adapter's software also creates a batch file that logs the user on to the network as a NetWare ODI client. High-quality documentation adds to the ease of installing and configuring the adapter.

Kingston's EtheRx PCMCIA Adapter offers a slightly lower price and fractionally better performance than the Accton Ethernet PCMCIA Card. However, we found its standard features to be inferior, especially its selection of network drivers.

		PRICE	SPEED INDEX	EASE OF USE	FEATURES	NETWORK DRIVERS: NETWARE SERVER	ODI	IPX	NETBIOS	UNIX
BEST	Accton Ethernet PCMCIA Card	$199	0.57	▲▲▲▲	▲▲▲▲	✔	✔	✔	✔	✔
RUNNER-UP	Kingston EtheRx PCMCIA Adapter	$179	0.58	▲▲▲▲	▲▲		✔			
RUNNER-UP	Boca PCMCIA 10Base-T	$195	0.57	▲▲▲▲	▲▲		✔			

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BYTE BEST

PORTABLE ETHERNET ADAPTERS

Portable adapters quickly connect via the parallel port to portable and desktop computers, which may not have an available expansion slot for a standard adapter. Because you connect these adapters to the parallel port, there are no I/O or interrupt conflicts, and there's no need to reset jumpers or switches.

The portable adapters we tested automatically detect which parallel port of the system is being used, and many automatically configure the adapter to run in the highest performance mode. All but six of the portable adapters we looked at came with connectors for both twisted-pair and thin coaxial cable.

But the trade-off for the convenience of a portable adapter is slow performance. For example, the fastest one we tested, the CLI PE-EPPct, has throughput similar to that of an 8-bit ISA NIC, even when using an EPP.



Unidirectional parallel ports send 8 bits of data at a time, but they receive only 4 bits of data at a time. Bidirectional parallel ports send and receive 8 bits of data at a time, which can improve performance by as much as 50 percent over that of unidirectional ports. EPPs can approximate the performance of a standard 8-bit internal network adapter. For EPP mode to function, it must be supported by both the system and the portable adapter.

KEY

Poor ▲ Fair ▲▲
Good ▲▲▲ Excellent ▲▲▲▲
Yes = ✔

When you can't sacrifice your printer port...

BEST OVERALL — Compex Para Port-E





This fast adapter uses a National Semiconductor Ethernet controller and comes with twisted-pair and BNC connectors. The Para Port-E supports standard, bidirectional, and EPP parallel ports, and it draws power from the system's keyboard connector (an external power adapter is available as a $70 option). This and the Longshine LCS-8834P-M (see the low-cost winners, below) are the only adapters that provide parallel pass-through ports, which let you attach a printer along with the portable adapter. The Para Port-E comes with a Novell NetWare ODI driver that automatically detects which parallel port is being used and sets the adapter to the highest performance mode.

		PRICE	SPEED INDEX	EASE OF USE	FEATURES	SUPPORTS EPP	PARALLEL PASS-THROUGH	WARRANTY (YEARS)	STATUS LIGHTS
BEST	Compex Para Port-E	$209	0.53	▲▲	▲▲▲▲	✔	✔	5	4
RUNNER-UP	CLI PE-EPPct	$199	0.54	▲▲▲	▲▲▲▲	✔		5	3
RUNNER-UP	Xircom Pocket Ethernet Adapter III	$349	0.49	▲▲▲▲	▲▲▲	✔		5	2
RUNNER-UP	GVC Technologies PE-002BT	$229	0.52	▲▲▲	▲▲▲	✔		5	6
RUNNER-UP	Kingston Dual Interface Ethernet Adapter	$245	0.52	▲▲	▲▲▲	✔		5	6
RUNNER-UP	SMC ElitePort Combo	$299	0.53	▲▲▲	▲▲	✔		5	4
RUNNER-UP	DEC Pocket Ethernet Adapter	$299	0.52	▲▲	▲▲	✔		1	2
RUNNER-UP	Lancast 4107 Pocket Ethernet Adapter EPP	$295	0.49	▲▲	▲▲▲	✔		3	6

Are speed and price important?

LOW COST — CLI PE-EPPct



This adapter's overall performance is by far the fastest in the under-$200 class, and it is second to no other adapter we tested at any price. It uses a Myson Ethernet controller and includes twisted-pair and BNC connectors. Powered by an external AC adapter, the PE-EPPct supports standard, bidirectional, and EPP parallel ports and provides automatic configuration. LEDs show power/link, reception, transmission, collision, and jabber.

		PRICE	SPEED INDEX	EASE OF USE	FEATURES	SUPPORTS EPP	PARALLEL PASS-THROUGH	WARRANTY (YEARS)	STATUS LIGHTS
BEST	CLI PE-EPPct	$199	0.54	▲▲▲	▲▲▲▲	✔		5	3
RUNNER-UP	Longshine LCS-8834P-M	$189	0.36	▲▲▲	▲▲		✔	1	3
RUNNER-UP	SVEC FD100	$129	0.32	▲▲	▲▲			5	3

For the best unidirectional performance...

STANDARD MODE — Xircom Pocket Ethernet Adapter III



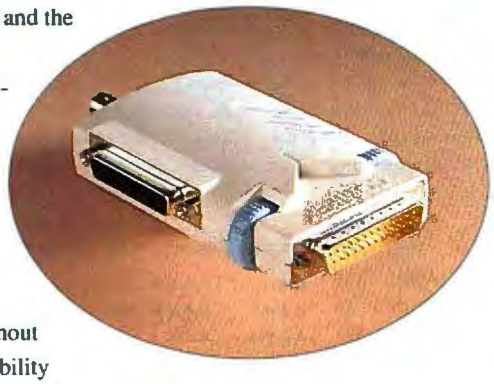
A compact unit measuring roughly the size of a business card, this adapter provides above-average unidirectional performance and is among the easiest to use, thanks to a rubber grip that makes the unit a breeze to attach and remove from the parallel port. The adapter draws power from PS/2-style mouse ports, and an external AC adapter is included. You must install a driver to use the Pocket Ethernet Adapter III in EPP mode. The excellent documentation stands out for its clarity.

		PRICE	SPEED INDEX[1]	EASE OF USE	FEATURES	SUPPORTS EPP	PARALLEL PASS-THROUGH	WARRANTY (YEARS)	STATUS LIGHTS
BEST	Xircom Pocket Ethernet Adapter III	$349	0.33	▲▲▲▲	▲▲▲	✔		5	2
RUNNER-UP	CLI PE-EPPct	$199	0.35	▲▲▲	▲▲▲▲	✔		5	3
RUNNER-UP	Kingston Dual Interface Ethernet Adapter	$245	0.34	▲▲	▲▲▲	✔		5	6
RUNNER-UP	GVC Technologies PE-002BT	$229	0.31	▲▲▲	▲▲▲	✔		5	6
RUNNER-UP	Longshine LCS-8834P-M	$189	0.33	▲▲▲	▲▲		✔	1	3
RUNNER-UP	SVEC FD100	$129	0.32	▲▲	▲▲			5	3
RUNNER-UP	Lancast 4107 Pocket Ethernet Adapter EPP	$295	0.31	▲▲	▲▲▲	✔		3	6

[1] Using unidirectional parallel ports.

HONORABLE MENTIONS

You can attach a printer cable to the parallel pass-through ports of the Compex Para Port-E and the Longshine LCS-8834P-M. This allows you to install a portable network adapter without losing the ability to print through the parallel port.



The Accton Ethernet PCMCIA Card's coupler comes with both 10Base-T and 10Base-2 connectors and still manages to be compact and light; the type of cabling used is auto-selectable. The 3Com EtherLink III offers a similarly flexible design. It comes with two types of cables, one with a BNC connector and the other with a twisted-pair connector.



The Black Box Modular Parallel Adapter features modular media units, so you don't need to purchase a new adapter if there is a media change. You simply attach the modular media unit that matches the cabling system, and the adapter reattaches to the network.



Dubious Achievements

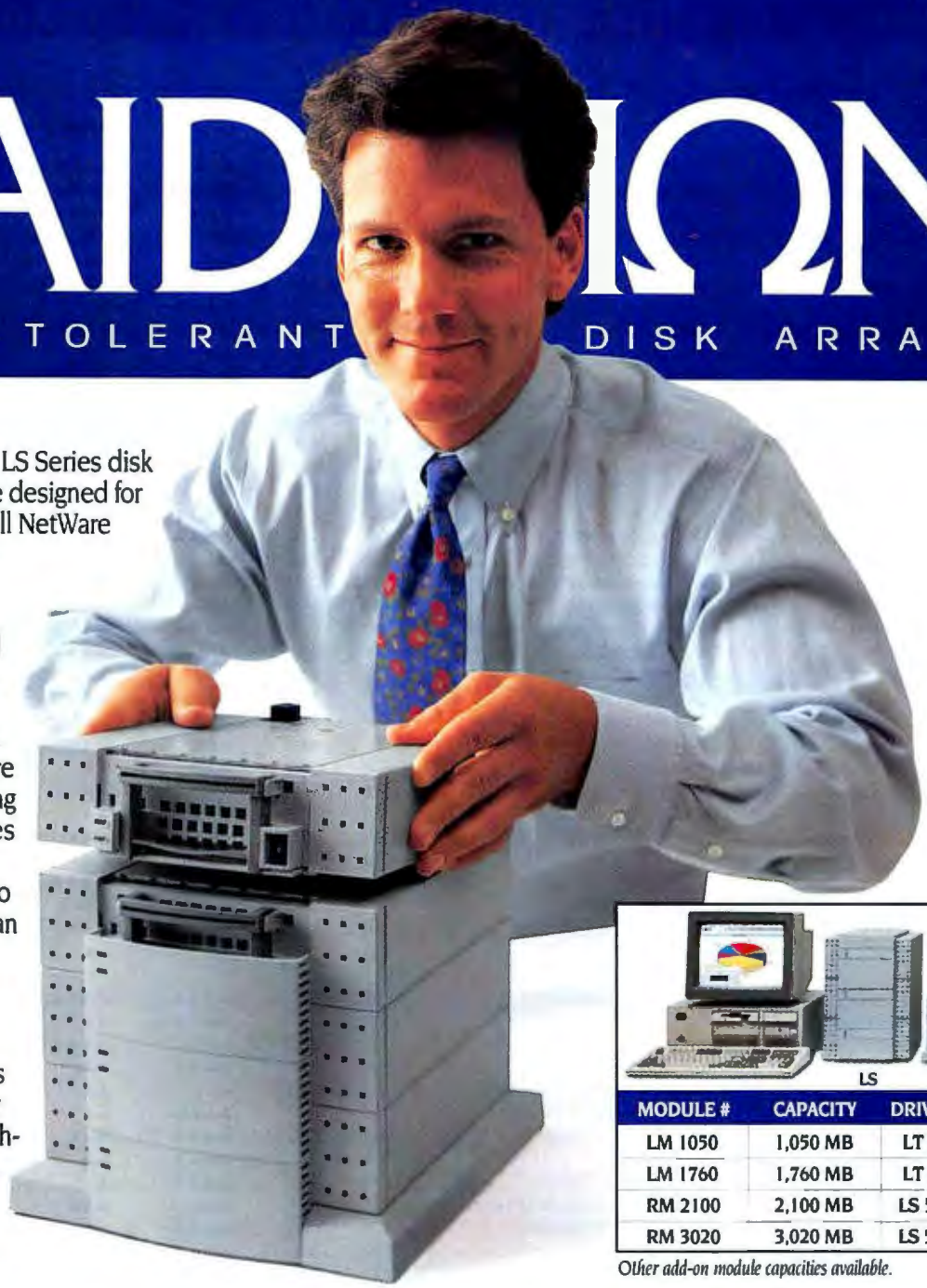
The GVC NIC-2003BT is software-configurable only with respect to its emulation mode (NE2000 or Western Digital 8013EBT). All other settings, including the media type, IRQ, base I/O, and interrupt, are configured through jumper settings, which can be tedious to change. This also requires that you open up your system to access the card. These settings can be altered via software, without powering down the host, on all other 16-bit ISA adapters.



The design of the Danpex EN-6000BT portable adapter is subpar. Your fingers tend to slip off the wheels that are used to tighten its screws. Its RJ-45 and BNC connectors are located on the back of the unit, along with the plug for the unit's external AC adapter. Two LEDs are sandwiched between the connectors, which makes them difficult to monitor.

RAIDION

FAULT-TOLERANT DISK ARRAYS



RAIDION® LT and LS Series disk array subsystems are designed for use with either Novell NetWare 3.1x/4.x or IBM OS/2.

Easy Upgrade. RAIDION, configured with 2 modules, provides mirrored fault tolerance up to 3 GB. Adding just one more module and installing RAIDWARE™, doubles user capacity and upgrades the array to RAID 5. Each array can be expanded to 32 modules and 93 GB.

Exceptional Warranty. There is a full 5 year warranty on all Micropolis high-capacity disk drives. Other RAIDION components carry a 3 year warranty.

MODULE #	CAPACITY	DRIVE FORM
LM 1050	1,050 MB	LT 3.5-inch
LM 1760	1,760 MB	LT 3.5-inch
RM 2100	2,100 MB	LS 5.25-inch
RM 3020	3,020 MB	LS 5.25-inch

Other add-on module capacities available.

Hot-Swap and Hot Replacement features allow RAIDION to be serviced while your network remains up and running. In addition, RAIDION can be configured with an On-Line Spare, which activates automatically upon drive failure ensuring continuous fault-tolerant operation.

Award Winning. In a benchmark comparison of arrays, Corporate Computing said: "*Raidion was our overall winner with an impressive combination of high performance, low cost, and unparalleled expandability.*" May 1993. RAIDION was also named LAN Magazine's Disk Array Product of the Year for 1994.

Economical. An LT Series three module 2 GB array is approximately $6,500. An LS Series Raid 5 array with a capacity of 6 GB lists for under $13,000. That's about $2.00 per MB. RAIDION's low price makes fault tolerance affordable for any size network. ***For the name of the reseller nearest you, call toll free* 1-800-395-3748.**

LAN MAGAZINE 1994 PRODUCTS OF THE YEAR

ENNE

OS/2

yes NetWare Tested and Approved

LAN TIMES READERS' CHOICE 1993

MICROPOLIS®

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Circle 108 on Inquiry Card.

ROLL CALL OF ETHERNET ADAPTERS

16-BIT NICS

VENDOR	MODEL	PRICE	SPEED INDEX[1]	EASE OF USE	FEATURES	CONTROLLER VENDOR
Addtron Technology	AE-200JL-N	$95	1.00	▲▲▲	▲▲▲▲	Winbond
Allied Telesis, Inc.	AT-1500BT Plus	$100	1.03	▲▲▲▲	▲▲▲	AMD
Alta Research Corp.	EtherCombo-16+ T/C	$99	1.00	▲▲▲▲	▲▲▲▲	National Semiconductor
Anco Technology, Inc.	E-16CT	$55	0.99	▲▲	▲▲	Anco
Ansel Communications	NS2000-3	$149	0.99	▲▲	▲▲▲	National Semiconductor
Arco Electronics	AC-9000S	$150	1.01	▲▲	▲▲▲	SMC
Artisoft, Inc.	Node Runner/SI 2000/T	$124	1.00	▲▲▲▲	▲	Artisoft
CeLAN Technology, Inc.	E2000C	$89	1.01	▲▲▲	▲▲▲	Realtek
CLI, Inc.	Ether-16T	$99	1.01	▲▲	▲▲	Myson
CNet Technology	CN888E	$149	1.00	▲▲▲▲	▲▲▲▲	National Semiconductor
Compex, Inc.	ENet 16 Combo/VP	$99	1.01	▲▲▲▲	▲▲▲	National Semiconductor
CompuLAN Technology, Inc.	E650 Plus	$99	0.99	▲▲▲	▲▲	UMC
Danpex Corp.	EN-2400P3	$88	1.00	▲▲	▲▲	Winbond
Digital Equipment Corp.	EtherWorks 3 Turbo/TP	$155	0.98	▲▲	▲▲▲	DEC
Elisa Technology	ETI-LAN002TLC	$45	1.00	▲▲	▲▲▲▲	National Semiconductor
GVC Technologies, Inc.	NIC-2003BT	$109	1.00	▲▲	▲▲▲▲	National Semiconductor
Hewlett-Packard Co.	PC LAN Adapter NC/16 TP	$119	1.02	▲▲▲▲	▲▲	AMD
HTI Networks	HT-NE 2000E3	$109	0.99	▲▲	▲▲▲	Winbond
IBM Corp.	LAN Adapter for Ethernet TP	$95	0.97	▲▲▲	▲▲	National Semiconductor
Intel Corp.	EtherExpress Flash TP	$139	0.99	▲▲▲▲	▲▲▲	Intel
Kingston Technology Corp.	EtheRx 2000 Plus Triple Interface	$89	0.97	▲▲▲▲	▲▲	National Semiconductor
Lancast	4116 Combo Card	$79	1.00	▲▲	▲▲▲▲	National Semiconductor
Lannet, Inc.	LEC-45T/AT	$269	1.01	▲▲▲	▲▲▲	SMC
Longshine Microsystem, Inc.	LCS-8634L-TBA	$79	1.01	▲▲▲▲	▲▲▲	LSIC
Microdyne Corp.	NE2000T plus	$97	0.99	▲▲▲	▲▲	National Semiconductor
National Semiconductor	InfoMover NE2000plus	$97	1.00	▲▲▲	▲▲▲	National Semiconductor
Ocean Information Systems	Ethernet-2000+3	$75	0.97	▲▲▲	▲▲	AMD
Racal InterLan, Inc.	EtherBlaster TP	$159	1.02	▲▲▲▲	▲▲▲	AMD
Standard Microsystems Corp.	Elite16T Ultra	$129	1.04	▲▲▲▲	▲▲	SMC
Sureman Computer Corp.	Surecom EP-301T	$119	1.01	▲▲▲	▲▲▲	Surecom/Maxonics
SVEC Computer Corp.	FD0490I	$69	0.99	▲▲	▲▲▲	UMC
Thomas-Conrad Corp.	TC5143-T	$98	1.00	▲▲▲▲	▲▲▲▲	National Semiconductor
BYTE 3Com Corp.	EtherLink III	$143	1.07	▲▲▲▲	▲▲▲▲	3Com
Top Microsystems Corp.	TE-2015C	$119	1.00	▲▲	▲▲▲	Winbond
Xinetron, Inc.	XI-321TCA	$79	1.01	▲▲	▲▲	RTC

PCMCIA CARDS

VENDOR	MODEL	PRICE	SPEED INDEX[1]	EASE OF USE	FEATURES	CONTROLLER VENDOR
Accton Technology Corp.	Ethernet PCMCIA Card	$199	0.57	▲▲▲▲	▲▲▲▲	Accton
Addtron Technology	EP-200T	$259	0.57	▲▲▲▲	▲▲	National Semiconductor
Alta Research Corp.	EtherMCIA UTP	$299	0.58	▲▲▲▲	▲▲▲▲	National Semiconductor
Ansel Communications	NP 6800-T	$249	0.58	▲▲▲▲	▲▲	National Semiconductor
Black Box Corp.	PCMCIA Ethernet Adapter 10BT	$349	0.57	▲▲▲	▲▲	Proprietary
Boca Research, Inc.	PCMCIA 10Base-T Ethernet Adapter	$195	0.57	▲▲▲▲	▲▲	Fujitsu
CLI, Inc.	IC-Card T	$395	0.57	▲▲▲▲	▲▲▲	Myson
CNet Technology	CN10BT	$299	0.58	▲▲▲▲	▲▲	National Semiconductor
Compex, Inc.	ENet-MCIA	$249	0.58	▲▲▲▲	▲▲	National Semiconductor
IBM Corp.	Credit Card Adapter for Ethernet	$225	0.58	▲▲▲	▲▲▲	National Semiconductor
Kingston Technology Corp.	EtheRx PCMCIA Adapter	$179	0.58	▲▲▲▲	▲▲	National Semiconductor
Microdyne Corp.	NE4000T	$249	0.58	▲▲▲▲	▲▲▲	National Semiconductor
National Semiconductor	InfoMover NE4100	$213	0.58	▲▲▲▲	▲▲▲▲	National Semiconductor
Thomas-Conrad Corp.	TC5041-T	$230	0.58	▲▲▲▲	▲▲▲▲	National Semiconductor
BYTE 3Com Corp.	EtherLink III PCMCIA	$225	0.60	▲▲▲▲	▲▲▲▲	3Com
Xircom, Inc.	CreditCard Ethernet Adapter	$299	0.56	▲▲▲▲	▲▲▲▲	Fujitsu

PORTABLE ADAPTERS

VENDOR	MODEL	PRICE	SPEED INDEX[1]	EASE OF USE	FEATURES	CONTROLLER VENDOR
Addtron Technology	EP-300T	$159	0.23	▲▲▲	▲	National Semiconductor
Black Box Corp.	Modular Parallel Adapter W/SPC	$325	0.33	▲▲	▲▲	National Semiconductor
CLI, Inc.	PE-EPPct	$199	0.54	▲▲▲	▲▲▲▲	Myson
CNet Technology	CN60ET	$249	0.37	▲	▲▲	Tamarack
BYTE Compex, Inc.	Para Port-E	$209	0.53	▲▲	▲▲▲▲	National Semiconductor
Danpex Corp.	EN-6000BT	$185	0.28	▲	▲▲	Realtek
Digital Equipment Corp.	Pocket Ethernet Adapter	$299	0.52	▲▲	▲▲	DEC
GVC Technologies, Inc.	PE-002BT	$229	0.52	▲▲▲	▲▲▲	SMC, Intel, Nat'l. Semi.
Kingston Technology Corp.	Dual Interface Ethernet Adapter	$245	0.52	▲▲	▲▲▲	National Semiconductor
Lancast	4107 Pocket Ethernet Adapter EPP	$295	0.49	▲▲	▲▲▲	Tamarack
Longshine Microsystem, Inc.	LCS-8834P-M	$189	0.36	▲▲▲	▲▲	Realtek
Standard Microsystems Corp.	ElitePort Combo	$299	0.53	▲▲▲	▲▲	SMC
Sureman Computer Corp.	Surecom EP-401	$235	0.49	▲▲	▲▲	Tamarack
SVEC Computer Corp.	FD100	$129	0.32	▲▲	▲▲	Realtek
Xircom, Inc.	Pocket Ethernet Adapter III	$349	0.49	▲▲▲▲	▲▲▲	Fujitsu

BYTE = BYTE Best. [1] Relative to the NE2000plus, which equals 1. Scores are not directly comparable among technology types. Excellent ▲▲▲▲ Good ▲▲▲ Fair ▲▲ Poor ▲

FEATURES CONTINUE ON NEXT PAGE

HARDWARE-CONFIGURABLE[2]	AUTOMATIC CONFIGURATION	SHARED RAM	PROGRAMMED I/O	DMA	MEDIA SUPPORT[4] THICK COAXIAL	MEDIA SUPPORT[4] THIN COAXIAL	BOOT ROMS NOVELL	BOOT ROMS UNIX	EMULATIONS 3COM	EMULATIONS NE2000	EMULATIONS SMC/WD
		✔	✔			✔	✔			✔	✔
	✔			✔		✔	✔	✔		✔	
✔	✔	✔	✔			✔	✔	✔		✔	✔
			✔			✔	✔			✔	
		✔	✔		✔	✔	✔			✔	✔
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	✔		✔				Third-party			✔	
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			✔				✔			✔	
	✔	✔	✔		✔	✔	✔			✔	✔
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	✔		✔		✔	✔	✔	✔		✔	✔
		✔	✔		✔	✔	✔			✔	
✔			✔			✔	✔	✔		✔	
			✔			✔	N/A	N/A	N/A	N/A	N/A
	C&S[3]	✔	✔				N/A	N/A	N/A	N/A	N/A
		✔	✔				N/A	N/A	N/A	N/A	N/A
	C&S	✔	✔				N/A	N/A	N/A	N/A	N/A
	C&S		✔				N/A	N/A	N/A	N/A	N/A
		✔					N/A	N/A	N/A	N/A	N/A
	C&S		✔				N/A	N/A	N/A	N/A	N/A
				✔			N/A	N/A	N/A	N/A	N/A
		✔	✔				N/A	N/A	N/A	N/A	N/A
		✔					N/A	N/A	N/A	N/A	N/A
	C&S	✔	✔				N/A	N/A	N/A	N/A	N/A
	C&S	✔					N/A	N/A	N/A	N/A	N/A
	C&S	✔	✔				N/A	N/A	N/A	N/A	N/A
		✔					N/A	N/A	N/A	N/A	N/A
	✔		✔			✔	N/A	N/A	N/A	N/A	N/A
	C&S	✔	✔				N/A	N/A	N/A	N/A	N/A
Automatic	N/A		✔				N/A	N/A	N/A	N/A	N/A
Automatic	N/A		✔				N/A	N/A	N/A	N/A	N/A
Automatic	N/A		✔			✔	N/A	N/A	N/A	N/A	N/A
Automatic	N/A		✔				N/A	N/A	N/A	N/A	N/A
Automatic	N/A		✔			✔	N/A	N/A	N/A	N/A	N/A
Automatic	N/A		✔			✔	N/A	N/A	N/A	N/A	N/A
Automatic	N/A	✔					N/A	N/A	N/A	N/A	N/A
Automatic	N/A	✔				✔	N/A	N/A	N/A	N/A	N/A
Automatic	N/A		✔			✔	N/A	N/A	N/A	N/A	N/A
Automatic	N/A		✔			✔	N/A	N/A	N/A	N/A	N/A
Automatic	N/A		✔			✔	N/A	N/A	N/A	N/A	N/A
Automatic	N/A	✔	✔			✔	N/A	N/A	N/A	N/A	N/A
Automatic	N/A		✔			✔	N/A	N/A	N/A	N/A	N/A
Automatic	N/A		✔			✔	N/A	N/A	N/A	N/A	N/A
Automatic	N/A						N/A	N/A	N/A	N/A	N/A

[2] All the NICs in this report were software configurable. [3] C&S = Card and Socket Services. [4] All products supported twisted-pair. N/A = not applicable. ✔ = yes.

ROLL CALL OF ETHERNET ADAPTERS

16-BIT NICS

VENDOR	MODEL	NETWORK DRIVERS: NETWARE SERVER	ODI	IPX	NETWARE NT CLIENT	NETBIOS	UNIX	NDIS	LOOPBACK
Addtron Technology	AE-200JL-N	✔	✔	✔	✔		✔	✔	✔
Allied Telesis, Inc.	AT-1500BT Plus	✔	✔		✔	✔	✔	✔	✔
Alta Research Corp.	EtherCombo-16+ T/C	✔	✔			✔	✔	✔	✔
Anco Technology, Inc.	E-16CT	✔	✔	✔	✔	✔	✔	✔	✔
Ansel Communications	NS2000-3	✔	✔					✔	✔
Arco Electronics	AC-9000S	✔	✔	✔	✔	✔		✔	✔
Artisoft, Inc.	Node Runner/SI 2000/T		✔			✔		✔	
CeLAN Technology, Inc.	E2000C	✔	✔	✔	✔	✔	✔	✔	✔
CLI, Inc.	Ether-16T	✔	✔	✔	✔	✔	✔	✔	✔
CNet Technology	CN888E	✔	✔	✔				✔	✔
Compex, Inc.	ENet 16 Combo/VP	✔	✔	✔				✔	✔
CompuLAN Technology, Inc.	E650 Plus	✔	✔	✔				✔	✔
Danpex Corp.	EN-2400P3	✔	✔	✔			✔	✔	
Digital Equipment Corp.	EtherWorks 3 Turbo/TP	✔	✔		✔	✔	✔	✔	✔
Elisa Technology	ETI-LAN002TLC	✔	✔	✔			✔	✔	✔
GVC Technologies, Inc.	NIC-2003BT	✔	✔	✔	✔	✔	✔	✔	✔
Hewlett-Packard Co.	PC LAN Adapter NC/16 TP	✔	✔				✔	✔	✔
HTI Networks	HT-NE 2000E3	✔	✔	✔	✔	✔	✔	✔	✔
IBM Corp.	LAN Adapter for Ethernet TP	✔	✔	✔	✔	✔		✔	✔
Intel Corp.	EtherExpress Flash TP	✔	✔	✔		✔	✔	✔	✔
Kingston Technology Corp.	EtheRx 2000 Plus Triple Interface	✔	✔					✔	✔
Lancast	4116 Combo Card	✔	✔	✔			✔	✔	✔
Lannet, Inc.	LEC-45T/AT	✔	✔	✔	✔	✔	✔	✔	✔
Longshine Microsystem, Inc.	LCS-8634L-TBA	✔	✔	✔			✔	✔	
Microdyne Corp.	NE2000T plus	✔	✔					✔	✔
National Semiconductor	InfoMover NE2000plus	✔	✔	✔	✔	✔	✔	✔	✔
Ocean Information Systems	Ethernet-2000+3	✔	✔	✔		✔			✔
Racal InterLan, Inc.	EtherBlaster TP	✔	✔	✔		✔	✔	✔	✔
Standard Microsystems Corp.	Elite16T Ultra	✔	✔	✔	✔	✔	✔	✔	✔
Sureman Computer Corp.	Surecom EP-301T	✔	✔	✔				✔	✔
SVEC Computer Corp.	FD0490I	✔	✔	✔			✔	✔	✔
Thomas-Conrad Corp.	TC5143-T	✔	✔	✔	✔	✔	✔	✔	✔
BYTE 3Com Corp.	EtherLink III	✔	✔	✔	✔	✔	✔	✔	✔
Top Microsystems Corp.	TE-2015C	✔	✔	✔	✔	✔	✔	✔	✔
Xinetron, Inc.	Xi-321TCA	✔	✔	✔				✔	✔

PCMCIA CARDS

VENDOR	MODEL	NETWORK DRIVERS: NETWARE SERVER	ODI	IPX	NETWARE NT CLIENT	NETBIOS	UNIX	NDIS	LOOPBACK
Accton Technology Corp.	Ethernet PCMCIA Card	✔	✔	✔		✔	✔	✔	✔
Addtron Technology	EP-200T	✔	✔	✔				✔	
Alta Research Corp.	EtherMCIA UTP	✔	✔			✔		✔	✔
Ansel Communications	NP 6800-T		✔					✔	✔
Black Box Corp.	PCMCIA Ethernet Adapter 10BT	✔	✔	✔	✔	✔		✔	
Boca Research, Inc.	PCMCIA 10Base-T Ethernet Adapter		✔					✔	✔
CLI, Inc.	IC-Card T	✔	✔	✔	✔	✔		✔	
CNet Technology	CN10BT		✔					✔	
Compex, Inc.	ENet-MCIA		✔					✔	✔
IBM Corp.	Credit Card Adapter for Ethernet		✔	✔	✔	✔		✔	✔
Kingston Technology Corp.	EtheRx PCMCIA Adapter		✔					✔	✔
Microdyne Corp.	NE4000T		✔					✔	✔
National Semiconductor	InfoMover NE4100		✔	✔				✔	✔
Thomas-Conrad Corp.	TC5041-T		✔				✔	✔	✔
BYTE 3Com Corp.	EtherLink III PCMCIA		✔			✔		✔	✔
Xircom, Inc.	CreditCard Ethernet Adapter		✔			✔		✔	✔

PORTABLE ADAPTERS

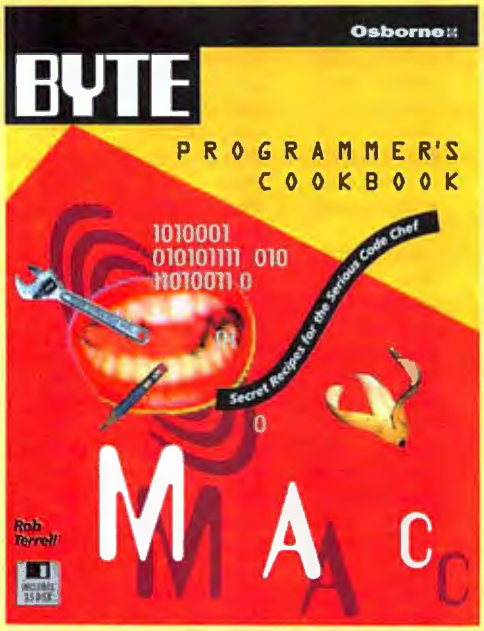
VENDOR	MODEL	NETWORK DRIVERS: NETWARE SERVER	ODI	IPX	NETWARE NT CLIENT	NETBIOS	UNIX	NDIS	LOOPBACK
Addtron Technology	EP-300T	✔	✔	✔		✔		✔	
Black Box Corp.	Modular Parallel Adapter W/SPC		✔	✔	✔			✔	✔
CLI, Inc.	PE-EPPct	✔	✔	✔	✔	✔		✔	✔
CNet Technology	CN60ET		✔	✔				✔	✔
BYTE Compex, Inc.	Para Port-E	✔	✔	✔				✔	✔
Danpex Corp.	EN-6000BT		✔	✔			✔	✔	
Digital Equipment Corp.	Pocket Ethernet Adapter		✔		✔	✔	✔	✔	✔
GVC Technologies, Inc.	PE-002BT		✔	✔			✔	✔	✔
Kingston Technology Corp.	Dual Interface Ethernet Adapter		✔					✔	✔
Lancast	4107 Pocket Ethernet Adapter EPP		✔	✔				✔	✔
Longshine Microsystem, Inc.	LCS-8834P-M		✔	✔			✔	✔	
Standard Microsystems Corp.	ElitePort Combo		✔	✔				✔	✔
Sureman Computer Corp.	Surecom EP-401		✔	✔				✔	✔
SVEC Computer Corp.	FD100		✔	✔			✔	✔	✔
Xircom, Inc.	Pocket Ethernet Adapter III		✔	✔		✔		✔	✔

BYTE = BYTE Best. ✔ = yes.

DIAGNOSTICS									
INTERSTATION TRANSMISSION	FRAME OVERRUNS	COLLISIONS	TRANSMIT-BUFFER SIZE (KB)	INTERRUPTS	STATUS LIGHTS	WARRANTY (YEARS)	PHONE	TOLL-FREE PHONE	INQUIRY NUMBER
			16	8	2	5	(510) 770-0120	(800) 998-4638	1105
			16	8	4	Lifetime	(415) 964-2771	(800) 424-4284	1106
✔		✔	16	9	4	Lifetime	(305) 428-8535	(800) 423-8535	1107
✔			16	8	1	2	(714) 992-9000	(800) 545-2626	1108
			3	8	2	5	(408) 452-5041	(800) 998-2675	1109
✔	✔	✔	4	4	3	5	(305) 925-2688	(800) 458-1666	1110
✔	✔	✔	32	5	1	5	(602) 670-7400	(800) 846-9726	1111
✔			16	8	2	Lifetime	(408) 434-6888	(800) 272-3526	1112
✔	✔	✔	8	7	3	5	(714) 572-8000	(800) 727-5250	1113
			16	8	2	Lifetime	(408) 954-8000	(800) 486-2638	1114
			8	8	1	5	(714) 630-7302	(800) 279-8891	1115
✔		✔	16	9	2	5	(408) 432-8899	(800) 486-8810	1116
			16	7	2	5	(408) 437-7557	(800) 452-1551	1117
✔	✔	✔	128	4	2	1	(508) 486-6949	(800) 344-4825	1118
✔	✔	✔	16	8	2	5	(510) 651-5817	None	1119
✔	✔	✔	16	8	2	5	(201) 579-3630	(800) 289-4821	1121
✔			N/A[3]	8	2	Lifetime	None	(800) 533-1333	1122
			16	9	2	5	(408) 745-0100	None	1123
✔	✔		16	7	2	5	None	(800) 426-2255	1124
✔	✔	✔	12	7	2	Lifetime	(503) 629-7354	(800) 538-3373	1125
✔			16	8	2	5	(714) 435-2600	(800) 435-2620	1126
✔		✔	3	8	2	3	(603) 880-1833	(800) 752-2768	1127
✔			8	4	2	1	(714) 752-6638	(800) 435-7535	1128
			8	8	0	1	(310) 903-0899	None	1129
✔			16	8	2	Lifetime	(703) 739-0500	(800) 255-3967	1130
✔			8	8	1	Lifetime	(408) 721-5000	(800) 231-6072	1346
✔	✔	✔	32	7	3	1	(818) 339-8888	(800) 325-2496	1347
✔			0	8	1	Lifetime	(508) 263-9929	(800) 526-8255	1348
✔	✔		16	7	2	Lifetime	(516) 435-6000	(800) 762-4968	1349
			16	8	2	5	(818) 333-7730	None	1350
✔			16	7	4	5	(714) 756-2233	None	1351
✔	✔	✔	16	5	4	5	(512) 836-1935	(800) 332-8683	1352
✔	✔	✔	2	15	1	Lifetime	(408) 764-500	(800) 638-3266	1353
✔			1.5	7	1	5	(408) 980-9813	(800) 827-8721	1354
			16	8	2	3	(408) 727-5509	(800) 345-4415	1355
✔		✔	3	8	2	2	(408) 452-8900	(800) 926-9288	1356
			16	1	4	1	(510) 770-0120	(800) 998-4638	1357
✔		✔	16	9	2	5	(305) 428-8535	(800) 423-8535	1358
			3	7	2	5	(408) 452-5041	(800) 998-2675	1359
			64	Unlimited	4	1	(412) 746-5500	None	1360
			2	7	0	5	(407) 997-6227	None	1361
			8	Unlimited	4	5	(714) 572-8000	(800) 727-5250	1362
			64	8	2	Lifetime	(408) 954-8000	(800) 486-2638	1363
			8	8	2	2	(714) 630-7302	(800) 279-8891	1364
✔	✔		16	7	2	5	None	(800) 426-2255	1366
✔			16	8	2	5	(714) 435-2600	(800) 835-2545	1367
			16	8	2	Lifetime	(703) 739-0500	(800) 255-3967	1366
			3	Unlimited	2	Lifetime	(408) 721-5000	(800) 231-6072	1369
✔	✔	✔	16	8	2	5	(512) 836-1935	(800) 332-8683	1370
✔	✔	✔	2	8	1	Lifetime	(408) 764-500	(800) 638-3266	1371
			4	15	2	5	(818) 878-7600	(800) 874-7875	1372
			8	2	4	1	(510) 770-0120	(800) 998-4638	1373
			0	2	2	1	(412) 746-5500	None	1374
✔	✔	✔	8	2	3	5	(714) 572-8000	(800) 727-5250	1375
			8	2	2	Lifetime	(408) 954-8000	(800) 486-2638	1376
			8	2	4	5	(714) 630-7302	(800) 279-8891	1377
			64	2	2	2	(408) 437-7557	(800) 452-1551	1378
✔	✔	✔	126	0	2	1	(508) 486-6949	None	1379
✔			8	0	6	5	(201) 579-3630	(800) 289-4821	1381
✔		✔	32	2	6	5	(714) 435-2600	(800) 435-2620	1382
✔	✔	✔	3	2	6	3	(603) 880-1833	(800) 752-2768	1383
			4	2	3	1	(310) 903-0899	None	1384
			32	1	4	5	(516) 435-6000	(800) 762-4968	1385
			8	1	3	1	(618) 333-7730	None	1386
✔			32	2	3	5	(714) 756-2233	None	1387
			8	3	2	5	(818) 878-7800	(800) 874-7875	1388

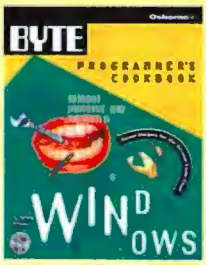
[3] Uses driver for buffering from 3 KB to 24 KB.

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FOR THE SERIOUS CODE CHEF

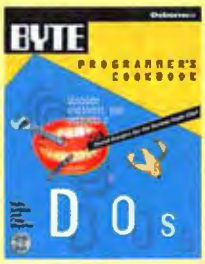


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PowerPC 604 Weighs In

Six execution units and dynamic branch prediction highlight IBM/Motorola's new processor

BOB RYAN AND TOM THOMPSON

With the backing of parents IBM, Motorola, and Apple, the PowerPC architecture has the best chance of taking significant market share away from the 80x86. The appeal of the original PowerPC—the 601—was that it offered the performance of the original Pentium for the price of a 486. The latest PowerPC, the 604, raises the stakes by offering performance that is 50 percent better than the latest Pentium, the 100-MHz P54C.

Pricing hadn't been established at the time of this writing, but Russell Stanphill, codirector of the IBM/Motorola Somerset design facility, says that 604 pricing will maintain the price/performance advantage that the PowerPC in general enjoys over the 80x86. The P54C currently sells for $995 per thousand and will likely be under $900 by fall. Despite its higher performance, the 604 will have to beat this price significantly to make reasonably priced 604-based personal computers possible.

At 100 MHz and with 1 MB of secondary cache and a 66-MHz bus, 604 simulations provide 160 SPECint92 and 165 SPECfp92, easily eclipsing the 100 SPECint92 and 80 SPECfp92 of the P54C. The design team achieved this performance by incorporating six separate execution units into the processor, three more than the 601 and two more than the 603. In addition, the 604 employs dynamic branch prediction to keep the execution units filled with instructions, yet it retains full compatibility with the other PowerPC processors.

The 604 will sample in the third quarter of this year and ship in at least limited-volume quantities in the fourth quarter. You can expect to see systems from Apple and IBM based on the part late this year or early next year.

Inside 604

With personal computers—as opposed to workstation-class machines—integer performance is everything, and the 604 microarchitecture betrays its PC leanings. Of its six execution pipelines, three are dedicated to integer functions. Two of the integer units handle single-cycle, register-to-register instructions, while the third is a more complex three-stage pipeline that handles integer multiplies and divides. The 604 is the first MPU (microprocessor unit) to offer three integer pipelines.

The other execution units in the 604 are an IEEE 754–compatible FPU, a load/store unit that moves data between registers and memory, and a branch unit that handles changes in the flow of instructions into the processor. The execution units are fed instructions and data by separate 16-KB, four-way set-associative instruction and data caches, which in turn communicate off-chip through the bus interface unit.

The 604 fetches up to four instructions per cycle from the instruction cache. It deposits these into an eight-entry prefetch/decode buffer. The bottom four entries of this buffer decode the instructions—that is, they determine the resources that each instruction requires.

Once decoded, up to four instructions per cycle move to the dispatch buffer. Here, the dispatch logic assigns a rename buffer as the destination for any writes to a register that an instruction makes, and it reads the instruction's operands from architectural registers or previously assigned rename buffers. The 604 contains 12 rename buffers for the 32 GPRs (general-purpose registers), and eight for the 32 FPRs (floating-point registers). To handle all the register accesses required by the multiple execution units, the 604 provides eight integer, three floating-point, and one condition register read ports. The use of rename buffers keeps instructions that are executing speculatively from updating architectural registers.

The dispatch logic also assigns each instruction an entry in the 16-entry reorder buffer, which tracks the status of every instruction—including whether the instruction is executing speculatively—from dispatch to completion. Thus, the 604 can have no more than 16 instructions executing—speculatively or otherwise—at any one time. If the reorder buffer is full, dispatch stops until one or more entries become available.

604 FACTS

- 100-MHz processor clock
- 1/x, 2/3x, 1/2x, 1/3x bus clock
- 32-bit address bus
- 64-bit data bus
- 3.3 V
- Less than 10 W
- 3.6 million transistors
- 196-mm² die
- 0.5-micron 4-metal layer
- 304-pin CQFP
- Six execution units
- Split caches
  - physically indexed
  - physical tags
  - MESI cache coherency
  - 128-entry two-way TLBs
- Load/store queues

Dispatch and Execution

From the dispatch buffer, instructions move to the execution units—up to four per cycle, although no more than one per execution unit per cycle. Instructions are dispatched in program order, and no instruction can dispatch after a branch instruction in the same cycle.

Each execution unit is fronted with a two-stage reservation station to keep a stalled execution unit from blocking dispatch to other units. If the execution stage is busy, instructions wait here until the first stage is clear. They also wait here if any of their operands are not available.

continued

A data-forwarding mechanism feeds the reservation stations, allowing operands to be made available to follow-on instructions before the instructions that produce them complete writeback. Note that if an instruction with all its operands available is dispatched to an idle execution unit whose reservation station is empty, the instruction issues immediately to the execution stage.

Instructions issue from the reservation stations to the individual execution units. With the branch, floating-point, and load/store units, instructions issue in order from the station to the unit. With the integer units, an instruction can issue out of order from the station to the unit. Thus, the 604 supports in-order dispatch; in-order issue within the branch, load/store, and floating-point units; out-of-order issue in the integer units; and out-of-order execution.

The 604 uses the reorder buffer to ensure that instructions complete in program order, thus ensuring the integrity of the architectural model. For example, if an instruction executing out of order causes an exception, the exception is noted in the reorder buffer and isn't handled until the instruction is retired from the buffer. Exceptions are always handled in program order.

Instruction Reflow

Unlike the 601 and 603, the 604 uses dynamic branch prediction to minimize delay when the normal sequential flow of instructions is changed by a branch instruction. Dynamic branch prediction is more complex than the static kind, but it adapts better to the run-time environment, thus ensuring better predictions.

Branch-prediction logic makes educated guesses about the outcome of a branch and begins fetching instructions from the predicted branch address before the condition the branch is based on is even tested. A misprediction, of course, results in a delay, but correctly predicted branches can result in zero-delay branching—the nirvana of every CPU designer.

Both the 601 and 603 rely on a "hint" bit in the coding of branch instructions to determine the direction of a branch. The 604 ignores this bit. Instead, it contains a 512-entry, direct-mapped BHT (branch history table) that maps four branch-prediction states: strong taken, weak taken, weak not-taken, and strong not-taken. The predicted state for a particular branch instruction is set and modified based on the history of the instruction.

The BHT feeds the BTAC (branch target address cache) with both the address of a branch instruction and the target address of the branch. The BTAC—a fully associative, 64-entry cache—stores both the address and the target of previously executed branch instructions. During the fetch stage, this cache is accessed by the fetch logic. If the current fetch address—the address used to get the next instruction from the cache—matches an address in the BTAC, then the branch target address associated with the fetch address is used instead of the fetch address to fetch instructions from the cache. Talk about cutting out the middle man.

Instructions fetched and executed based on a branch prediction are considered speculative until the branch is resolved; that is, until it is known whether the branch prediction was accurate. No speculative instruction is permitted to update the architectural state. The 604 lets instructions execute speculatively through writeback, but only nonspeculative instructions can be retired by the completion unit.

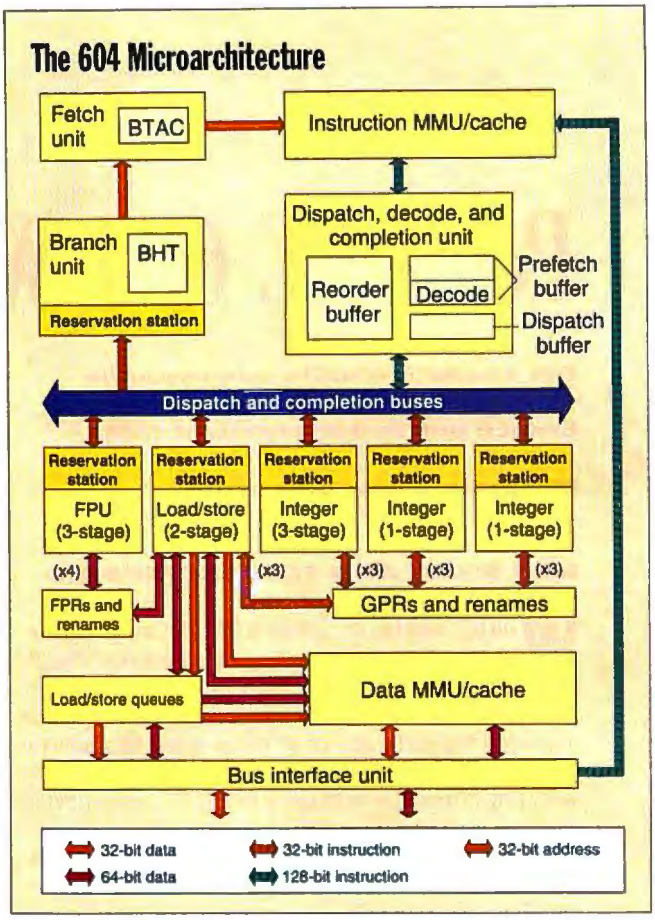
Instruction Finale

The 604 lets instructions execute out of order and execute with up to two levels of speculation, but it doesn't let such instructions affect the architectural state of the processor. In other words, such instructions cannot affect any user-visible registers or memory locations. Registers and memory can be touched only by nonspeculative instructions in program order. This rule is enforced by the completion unit. (The exceptions to this rule are the Counter and Link registers used by branch instructions. These employ shadow registers to back out of mispredicted branches.)

The completion unit uses the reorder buffer to retire instructions. It retires instructions in program order, up to four instructions per cycle. It won't retire an instruction that is labeled speculative, nor will it retire one that executed out of order unless all previous instructions have been retired. The completion unit knows the order of instructions because this information is supplied to the reorder buffer when the instruction is dispatched.

Likewise, the 604 has an internal mechanism to mark instructions executing speculatively and remove the marking when the speculative branch is resolved. Of course, if the branch is found to be mispredicted, the mechanism must be able to expunge the speculative instructions from the pipeline and the reorder buffer and to invalidate writes such instructions made to the rename buffers. Due to pending patent applications, the Somerset design team declined to give details of this internal tracking mechanism other than to characterize it as relatively straightforward.

In the future, you will see faster versions of the 604 as IBM and Motorola improve their processor technology. The 604 also gives strong indications of how the PowerPC 620—the workstation member of the PowerPC line due in the fall—will play out. The 620 will issue six instructions per cycle, at least two of which will undoubtedly be floating-point instructions. At present, however, the 604's integer performance is a perfect fit with the types of applications that dominate desktop computing. ■



Bob Ryan is a BYTE technical editor, and Tom Thompson is a BYTE senior technical editor at large. You can contact them on the Internet or BIX at b.ryan@bix.com and tom_thompson@bix.com, respectively.

Retrofitting OS/2 for SMP

OS/2 can now exploit the current generation of 80x86-based symmetric multiprocessing hardware

MICHAEL S. KOGAN

Although IBM's microkernel-based Workplace OS will support SMP (symmetric multiprocessing), IBM has also chosen to retrofit the existing OS/2 2.1 to support 80x86-based SMP platforms. The two systems are very different beasts. In Workplace OS, SMP arises naturally from the Mach foundation. In OS/2, SMP is a retrofit. Fortunately, the necessary techniques are well understood—many Unix kernels have undergone the same transformation. To enable OS/2 2.x for SMP, global system data must be partitioned on a per-processor basis and be restructured to support true concurrent execution of processes and threads. Algorithmic enhancements are needed in the areas of multitasking, memory management, synchronization, and interrupt management.

OS/2 on a Single 80x86 Processor

UP (uniprocessor) OS/2 relies heavily on two assumptions that SMP threatens: that the kernel can't be preempted and that interrupts can be disabled. When a thread runs in user mode (at ring 3, the least-trusted 80x86 privilege level), it can be preempted; when it runs in kernel mode (at the most-trusted level, ring 0), it cannot. A thread requesting system service calls `EnterKMode` to save its context, switches to a kernel (ring 0) stack, and then enjoys full access to the resources of the system. Once in kernel mode, the thread must finish its job quickly and return to user mode, or block awaiting some event.

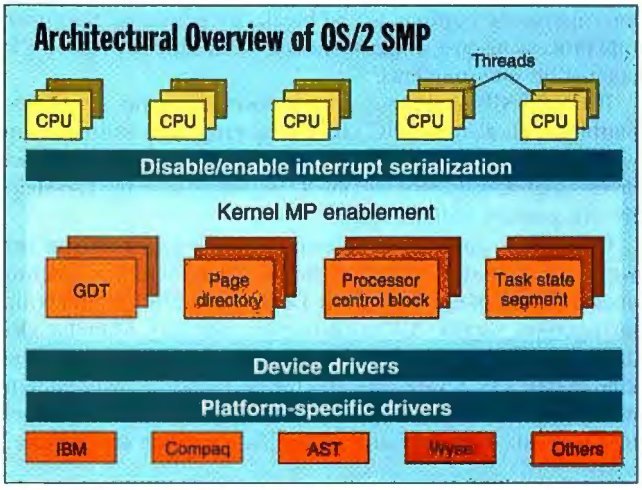
The first assumption is that threads are never preempted in kernel mode—if interrupted, execution resumes after interrupt service, even if a higher-priority thread becomes ready to run. So while a thread in kernel mode is interruptible, it is not preemptible.

Hardware interrupts are processed in interrupt mode. When an interrupt occurs, the processor switches to ring 0, OS/2 switches to an interrupt stack, and the interrupt handler runs. If the interrupt occurred in user mode and a thread moves to the ready state, a reschedule will be forced by consecutive calls to `EnterKMode` and `ExitKMode`. If the interrupt occurred in kernel mode, no dispatch cycle occurs, and control is immediately returned to the interrupted thread.

The other assumption is that interrupts can be disabled using the CLI/STI (clear/set interrupt enable flag) idiom, to synchronize kernel-mode, user-mode, and interrupt-mode access to shared data structures.

OS/2 SMP Architecture

The problem with the first assumption—that the kernel is nonpreemptible—is that a kernel thread running on one processor can stomp on a data structure shared with a kernel thread running on another processor. The initial OS/2 SMP release solves this problem by avoiding it. Much of the kernel is treated as a large critical section that can be executed by just one thread—not one per processor, but one per system. Entry points into the OS/2 kernel must acquire a semaphore called a *spinlock*, the primary synchronization construct used in any MP (multiprocessor) system to guarantee mutually exclusive access to MP-critical sections of code. It's called a spinlock because a processor executes a tight spin loop waiting for the lock to be released. On 80x86 processors, threads acquire spinlocks using the XCHG instruction.



Platform-specific drivers isolate the kernel and device drivers from the specifics of each SMP platform.

Will the kernel spinlock compromise the scalability of OS/2 SMP? Yes, but probably not as severely as you might think. Applications spend most of their time in user mode. Threads that do enter the kernel don't spend much time there. Some kernel components, including the scheduler and semaphores, are multithreaded and can run on multiple processors. Finally, many DLL-based system services—including all of Presentation Manager—run in user mode, where they can exploit SMP.

The problem with the second assumption—that interrupts can be disabled to synchronize kernel-mode, user-mode, and interrupt-mode access to shared data structures—is that disabling interrupts on one processor does not lock out interrupt service code running on another

processor. So spinlocks are used throughout the kernel, instead of CLI/STI and simpler RAM-based kernel semaphores, and are also used by device drivers and DLLs to guard access to data structures. New APIs enable the kernel, device drivers, and DLLs to manage spinlocks. Vendors of third-party drivers and DLLs will have to use these APIs to exploit SMP.

Because SMP systems handle interrupt management and interprocessor connection and communications in different ways, OS/2 SMP defines a set of interfaces for PSDs (platform-specific drivers) that isolate the kernel and device drivers from the specifics of the SMP hardware platform. A PSD, similar in concept to (but much simpler than) the Windows NT HAL (hardware abstraction layer), contains code to support the low-level functions of initialization, processor management, hardware interrupt management, and interprocessor communications.

Interprocessor communication enables a thread running in kernel mode on one processor to force another processor to perform an event, such as flushing the TLB (translation lookaside buffer), rescheduling, or suspending operation. Most SMP hardware platforms allow interprocessor software interrupts to be sent on a per-processor or broadcast basis. Messages are stored in the memory that is shared by all processors in the SMP configuration.

Device Drivers

In the first release of OS/2 SMP, all hardware interrupts vector to one processor. If they didn't, existing device drivers that use CLI/STI to synchronize the execution of their kernel-mode and interrupt-mode portions would break. By performing all interrupt processing on a single processor, OS/2 SMP provides a UP-compatible environment.

If OS/2 SMP is running on a platform that is not 8259-compatible, such as the APIC (advanced programmable interrupt controller) found in new Pentium P54C chips, existing device drivers that directly program the 8259 instead of using DevHelps for this purpose will not work.

OS/2 SMP can support interrupts across processors in two ways. Existing device drivers that use spinlocks for synchronization, and that use the existing DevHelp interfaces for interrupt management, support MP in a driver-granular way. Multithreaded drivers modified for reentrancy can support a more fine-grained kind of MP. OS/2 SMP provides the necessary infrastructure to make these modifications easy—new DevHelps for spinlock management, and the platform-specific extension architecture.

Memory Management

In OS/2 SMP, multiple processes and threads can be active and mapped in memory. Therefore, the system must duplicate several major data structures and provide efficient access to processor-specific data. Each processor has its own page directory, GDT (global descriptor table), TSS (task state segment), and PCB (processor control block).

The OS/2 SMP kernel keeps the contents of page directories consistent across processors. Whenever a shared page directory entry or page table entry is modified, all processors flush their TLBs to ensure memory coherency.

The OS/2 GDT contains special descriptors that the kernel uses to map data structures related to the current process. On a context switch, OS/2 2.1 updates the base address of these descriptors rather than using multiple descriptors, so that these data structures appear at the same virtual address regardless of which process is running. To avoid the need to rewrite code that expects these data structures to appear at a fixed virtual address, the SMP kernel allocates a GDT for each processor. The GDT page that contains the special selectors is committed on a per-process basis, and the other GDT pages are shared among all GDTs.

The TSS controls stack switching on ring transitions. One TSS is allocated per processor, to enable concurrent ring transitions by threads running on different processors. PCBs are the main data structures used to access the per-processor data structures, such as the page directory, GDT, TSS, and spinlock information.

A final new data structure, called the PSA (processor save area), contains global kernel variables and per-processor data. The PSA contents are unique on a per-processor basis but appear at the same virtual address across processors. The PSA contains pointers to the processor's PCB and other processor-specific data, including links to the current process, the thread for the processor, and scheduling information.

The Uniprocessor Compatibility Challenge

OS/2 1.x made ring 2 accessible for IOPL (I/O privilege) segments, enabling 16-bit OS/2 programs to use I/O-sensitive instructions such as IN, OUT, CLI, and STI. IN and OUT access I/O ports; CLI and STI disable/enable interrupts. In the UP environment, interrupt disabling synchronizes user-mode threads accessing shared resources, manages critical sections between user-mode threads and device-driver interrupt handlers, and ensures that I/O device commands are delivered to devices without interruption.

To ensure backward compatibility and make CLI/STI work in an SMP environment, OS/2 SMP does several things. IOPL moves from ring 2 to ring 0, and the TSS IOBM (I/O bit map) is cleared. Since IOPL is ring 0, the TSS IOBM governs I/O port access. By clearing the IOBM, the process still has access to the I/O ports. Most important, though, general protection faults occur when CLI and STI instructions issue from ring 2, enabling the kernel to take control and emulate the interrupt-flag semantics.

The kernel handles interrupt-flag emulation with the special CLI/STI spinlock. When a thread executes a CLI, the OS/2 SMP kernel acquires the CLI/STI spinlock; when a thread executes an STI, the kernel releases the CLI/STI spinlock. Thus, only one user-mode thread at a time can execute with interrupts disabled.

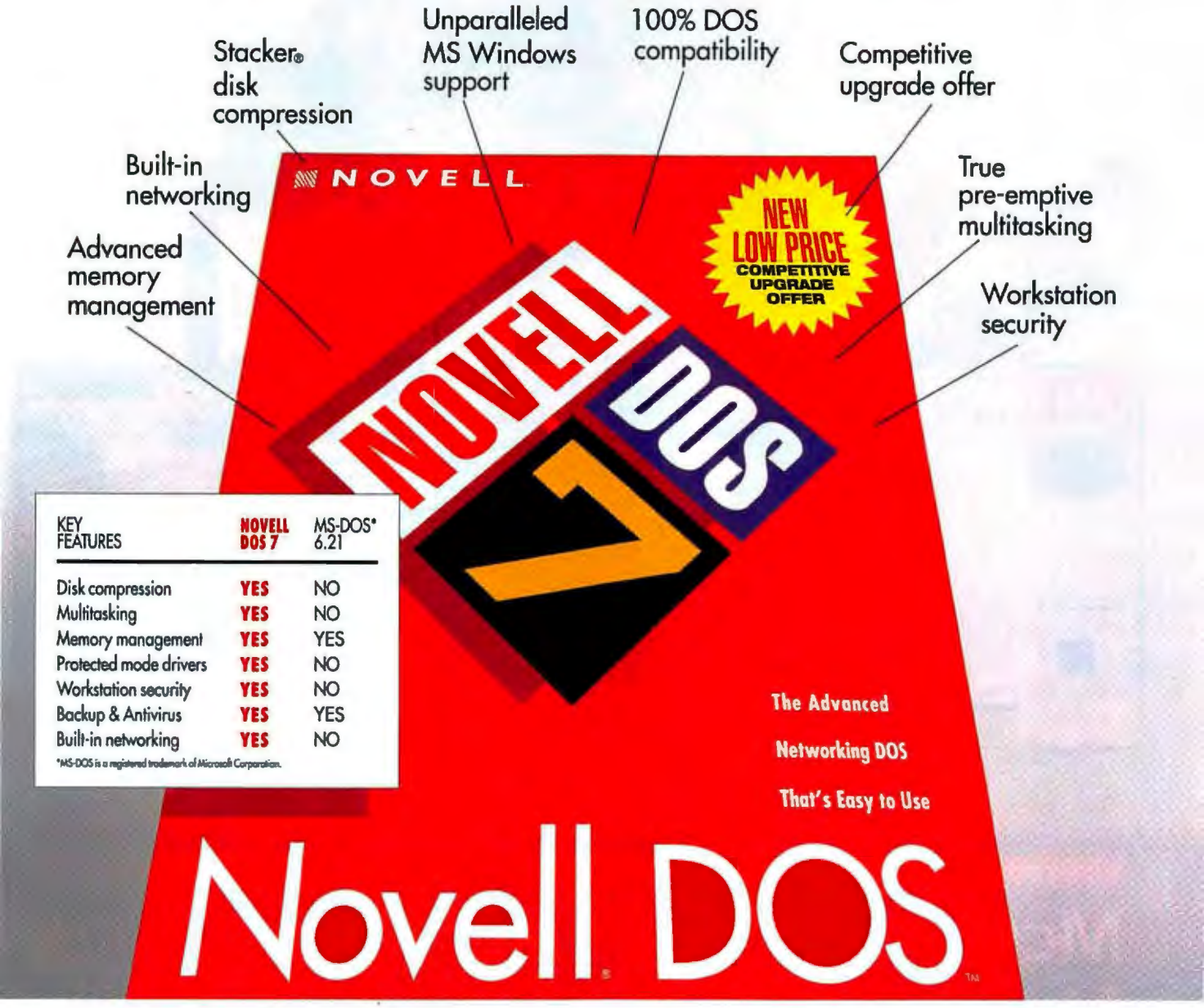
Existing OS/2 programs that use the INC and CMPXCHG instructions for synchronization can potentially run into problems. These instructions don't generate a memory lock and can't ensure that only a single processor is accessing the memory. For these programs, OS/2 SMP provides a UP execution mode that prevents a process's threads from running concurrently on different processors. To make a program run in UP mode, you'll use a utility to stamp its EXE header.

Applications that have a UP priority dependency can also have problems. An application might, for example, assume that an idle class thread will not run while a regular class thread is running. Again, UP mode is the way to ensure compatibility.

OS/2 SMP should be an effective first implementation, delivering real scalability for multithreaded OS/2 programs as well as concurrent DOS/Windows sessions. An attractive solution for inexpensive, small-footprint clients and servers, it should be available by the time you read this as a preloaded product on systems from IBM, Compaq, Wyse, and AST. ■

Michael S. Kogan is president of Kogan Associates, Inc. (Atlantic Beach, FL), a consulting firm specializing in personal computer software and systems. He is coauthor of The Design of OS/2 *(Addison-Wesley, 1992), a freelance writer for computer publications, and a visiting professor at Nova University. He can be reached on CompuServe at 76711,212 or on BIX c/o "editors."*

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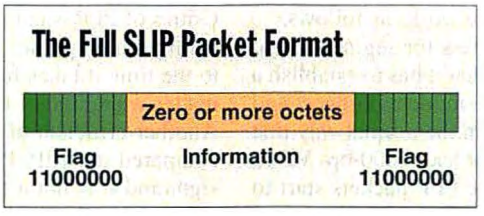
From Here to There

A look at the value of the Point-to-Point Protocol in creating wide-area networks

BEN SMITH

The struggle to interconnect networks is intensifying. More and more, the networks in our offices carry two or more protocols. At the same time, these networks need to connect to other networks located across town or across the continent. The terms *multiprotocol* and *wide-area network*, or WAN, bring nods of affirmation during any discussion. The Point-to-Point Protocol, or PPP, can boast both terms and still shun the word *proprietary*. No wonder it has become popular.

PPP can be used to inexpensively extend a LAN out to a single remote device, to connect to distant segments of a LAN, or even (through the use of routers, such as the Telebit NetBlazer) to connect different LANs together. It was designed to create temporary physical links while using modems over phone lines, but it can be used for any serial-line links—even high-bandwidth connections, such as T1.



The SLIP protocol is very simple, but it doesn't provide error checking and is not based on any widely accepted standards.

PPP was developed by the IETF (Internet Engineering Task Force) through the cooperative work of dozens of individuals and commercial enterprises and the Internet's RFC (Request for Comments) publication process (originally RFCs 1171 and 1172, which were replaced by RFC 1331 and others). The motivation was the advancement of the traditional serial links that still form the twigs of much of the Internet throughout the world.

In the Unix world, these links used to be maintained by a store-and-forward file transfer and command-execution method called UUCP, the complete opposite of the stream-like TCP/IP network protocol. The development of fast and inexpensive dial-up modems has provided the technology to make serial-line networking feasible over more than just leased lines and direct RS-232 serial links.

The first generation of IP-over-serial lines, SLIP (the Serial Line Internet Protocol, defined in RFC 1055), was satisfactory only in a simplistic way. It was not based on any widely accepted standards and provided only minimal functionality—and that only to the TCP/IP world. But SLIP (see the figure "The Full SLIP Packet Format") is simple both in design and implementation, and therefore its use spread quickly. Now PPP is rapidly replacing SLIP and is providing the basis of serial-line extensions for many other protocols as well.

The Data Link

PPP is primarily a data-link protocol, but it goes beyond that. The design goals of PPP were to provide a method for establishing, configuring, and evaluating serial links and then encapsulating network-layer datagrams (i.e., blocks of data) over these links. PPP also includes a growing set of protocols for establishing different network-layer protocols, such as IP, IPX, Banyan Vines, and any implementation of the OSI (Open Systems Interconnection) network layer.

Unlike SLIP, PPP is based on a widely accepted structure, the HDLC (high-level data-link control) protocol (see the figure "The Full PPP Packet Format" on page 272). HDLC is an internationally adopted ISO standard. It is also the basis for the data-link layers of X.25, ISDN, V.42, Frame Relay, and even the SDLC (synchronous data-link control) protocol of IBM's SNA (Systems Network Architecture) networks.

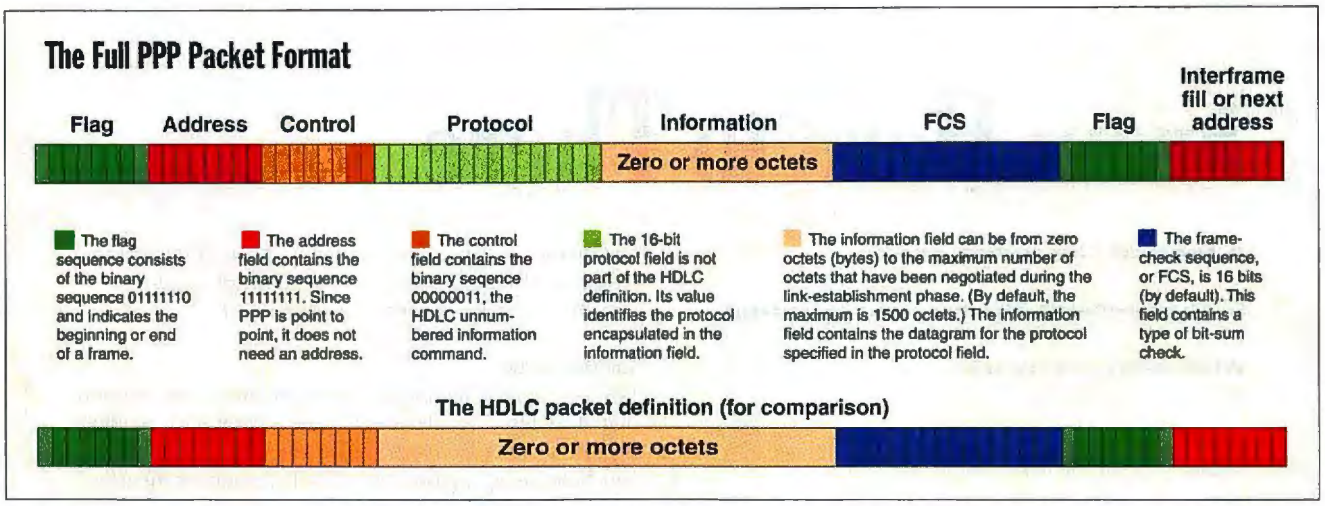
One of the major uses of the HDLC structure is for identifying the various protocols that it can carry. Just like Ethernet, PPP can carry several different ones simultaneously.

As a general rule, PPP encapsulates the packets of the passenger (i.e., network-layer) protocol rather than fragmenting them, as does ATM (Asynchronous Transfer Mode) in its design for optimization of available bandwidth. The emphasis of PPP is on maintaining robustness over serial links of questionable integrity. Nonetheless—and despite its far more sophisticated packet structure and management protocols—it's not as bad as many SLIP advocates predicted.

Protocols Within

PPP defines two types of internal protocols: the LCP (Link Control Protocol), which is used for establishing, configuring, and testing the data-link connection; and the NCPs (Network Control Protocols—not Novell NetWare Core Protocols), each of which is defined for its corresponding network-layer passenger type. An example of an NCP is IPCP (the Internet Protocol Control Protocol, which is described in RFC 1332).

In this short discussion about PPP, I'm focusing more on the facilities provided by LCP than on the various NCPs. The format of the LCP and NCPs is the same; only the content is different. The former is purely PPP administrative; the latter contains the passenger-network



The PPP protocol is far more complex than SLIP, but it offers error checking and is based on the HDLC standard. It can support a host of network protocols above it.

packets. The LCP and NCP packets have the same structure. The signal that a packet is being used for LCP is held in the protocol field. All LCP packets have a protocol identifier with a C0 (hexadecimal) in the first octet.

As with nearly all communications protocols, a successful PPP session consists of at least three stages: establishing the link, carrying on the conversations of the encapsulated protocols, and shutting down the link. It's important to note that each of these phases happens within the structure of the HDLC/PPP format, and, as such, they happen only over an already-established physical link. For example, assuming that the physical link consists of two modems and a phone line, the scheme works as follows.

Say that network segment A has business for segment B, so the PPP bridge (or router) software sees that it has to establish a connection to segment B via modem. The modems connect and establish the best physical link possible in the normal way that modems do. (We can hope that the link is at least 9600-bps V.32.) Once the physical link is established, the PPP packets start to flow.

The first PPP packets are purely LCP packets. This is the first active phase of a PPP session, establishing the link. During this phase, the two PPP segment servers test the physical-link quality and negotiate the maximum size for PPP packets. There is nothing in this phase that is specific to the passenger (i.e., network-layer) protocol or its configuration.

Once the data link has been established, PPP may move into an authentication phase if the implementation requires it. This is an implementation-specific option. There are still no NCP packets at this stage.

Only after these preliminary steps have been successfully completed does PPP enter the second phase, and the NCP packets start to flow. Each of the NCP packet headers indicates what kind of passenger is riding in the information field of that packet. The first NCP packets for an encapsulated protocol are likely to be special negotiations for that protocol—for example, special IPCP packets are used to set up the IP link and possibly to negotiate a compression method. Like the NCP packets, these network-layer-control packets carry their own special values in the protocol field; the first octet has an 80 (hexadecimal). At this point, the actual datagrams begin to flow.

This second phase is not limited to a single passenger link; several concurrent links, even those using different link-layer protocols, can be carried simultaneously. Nor is this phase of the PPP session limited to NCP packets. There may also be some LCP packets for regular testing of the link and for renegotiating the maximum packet size.

The final phase of a PPP session shuts down the PPP services at both ends. When you consider the types of media over which this network is established—phone lines, satellite links, and the like—you realize that this phase, known as the link-termination phase, can actually happen at any time. PPP is designed to cope with this unpredictability.

Catching On

Critics of PPP wag their fingers at the overhead of its extensive configuration phase. However, this is a trivial matter compared to the time it takes for modems to establish a physical link, no matter what kind of transmission is going to take place over it. Another criticism of PPP is its complexity, particularly when compared to SLIP. PPP was not a trivial piece of work to design, and it is not a trivial task to implement it. But the complexity of PPP provides for greater flexibility and greater reliability over less-than-ideal physical connections. PPP's foundation on established protocols also means that engineers who have already worked on other HDLC-based protocols will be working with familiar structures when they work with PPP.

Because PPP can carry so many other protocols, there are already free implementations not only for Unix platforms (there are many), but also for Macs (MacPPP), PCs (WG7J), and the Amiga (AmigaNOS). PPP is also implemented in many commercial packages, such as Novell's LAN WorkPlace for DOS, FTP Software's PC/TCP, Distinct's and Frontier Technologies' Microsoft Windows DLLs for PPP, and Morning Star Technologies' PPP for Unix platforms. In addition, you can find PPP in terminal servers and routers, such as the aforementioned Telebit NetBlazer, as well as Livingston Enterprises' PortMaster PM-11, Xylogics' MicroAnnex XL and Annex Three, Datability's VCP 200/300, and 3Com's CS/2100, among many others.

All the work that has been put into developing and implementing PPP has been worth the effort. It is fast becoming the de facto standard for inexpensive long-distance network connections, it is network-layer-protocol-independent, and it's freely available. ■

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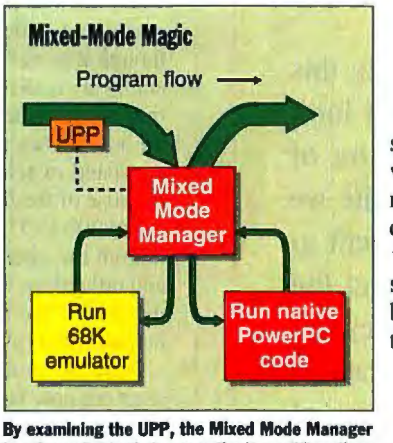
Port Mac Applications to the PowerPC

Apple's Mixed Mode Manager and Universal Procedure Pointer greatly ease the transition

RICK GREHAN

Longtime readers will remember that the IBM PC started out as an 8088 machine. Over time, it and the countless clones that followed grew to be 286 machines, then 386 machines, then 486 machines, then Pentium machines. With the arrival of NT, the notion of a PC clone has blurred. Machines have appeared that look to the casual observer like a high-end PC clone, but inside beats the heart of an Alpha, a Mips processor, a PowerPC, or possibly even an Intel processor.

The incursion of non-Intel CPUs into what had been a virtually all-Intel world continues to assault applications developers with a series of problems—which are, happily, closely pursued by solutions. A similar production is unfolding on the Macintosh stage, heralded by the advent of the PowerPC-toting Power Macs. Up to now, the Macintosh was a 680x0 (abbreviated as 68K hereafter) platform, and the installed base of applications software—never mind the Mac OS and Toolbox code—is a gigantic body of 68K-based code that no sane person would simply discard as a casualty necessarily incurred on the road to RISC.



By examining the UPP, the Mixed Mode Manager handles switching between native PowerPC routines and routines executed by the 68K emulator.

ANSI C Is King

The name of the game is C. When the first edition of *Inside Macintosh* appeared, the language that was used to describe data structures and call sequences was Pascal. This is no longer the case, however; C is the lingua franca when working with Power Macs.

To be accurate, ANSI C is the language to use with Power Macs. To non-Mac programmers, this may seem to be a given: If you say "C," you really mean "ANSI C." Not so among Mac programmers; nonstandard constructs not only were encouraged to flourish, but in some cases were required. For example, some Toolbox routines expect—and return—parameters in registers; others use a Pascal calling convention, which places parameters atop the stack and the return address beneath.

While compiler designers can provide "wrapper" code to insulate the C program from these peculiar calling conventions, if a programmer wanted to *hook* a Toolbox call (i.e., provide his or her own code to replace the Toolbox routine), he or she was frequently forced into assembly language. Consequently, Mac C compilers often allowed in-line assembly code. For example, Symantec's Think C provides a non-ANSI `asm{ ... }` construct that permits the programmer to commingle C and assembly.

The requirement for ANSI compliance not only provides a framework by which the Mac's API can be rigorously defined, but it can also produce some performance gains. For instance, a lazy programmer might be tempted to ignore placing a return type on a function declaration for a routine that returns no value:

```
sillyFunc(long *x)
{    *x=*x+12;
}
```

In this case, the C compiler—assuming it's lax enough to permit this—will assume that `noValFunction()` returns an argument of type `int` so the compiler will emit code to return an `int` derived from the value of the last statement executed in the function. It's better to define the function's return type:

```
void sillyFunc(long *x) ...
```

so the compiler won't generate the unneeded code.

Finally, if you want to lessen the programming work you'll have to do to verify that your application runs on all Macs, you should remove any explicit dependence on the size of the `int` data type. On 68K Macs, depending on the compiler, an `int` could be 2 or 4 bytes (some compilers provide switches that let you toggle between the two). On the PowerPC, an `int` is always 4 bytes.

Preliminary Apple documentation relating to the porting process recommends you use variables of type `int` only to access the "natural word size" of the machine, such as the declaration of a variable used only as the index in a `for` loop. Use `short` for 2-byte integers and `long` for 4-byte integers.

Floating Point

Programmers familiar with SANE (Standard Apple Numeric Environment) will be saddened to know that the 64-bit comp (short for *computational*) data type and the 80-bit extended floating-point type are not supported on Power Macs. (The comp data type was basically a 64-bit signed integer, with the added advantage that it could return a NaN [not a number] value, useful in indicating

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arithmetic exceptions. The comp data type performed exact arithmetic, such as is required in accounting.) This "out with the old, in with the new" campaign is necessary because the PowerPC chip's integrated FPU handles single- and double-precision numbers (32 and 64 bits, respectively) as native data types.

What made the 80-bit extended format useful was the fact that single-precision, double-precision, and comp types could be converted to the 80-bit extended type with no loss of precision. This simplified the mixing of operands of different types. In fact, the SANE package used the extended type for all its internal calculations. Ironically, the *Apple Numerics Manual* referred to the single-precision, double-precision, and comp types as "application types" rather than as arithmetic types; they were deemed to have value as space-saving data structures rather than as data structures to be used during calculations.

Fortunately, if you need the precision, Power Macs do support a 128-bit long double. You will, however, pay a speed penalty; operations performed on long doubles are handled in emulation fashion rather than by the PowerPC's FPU.

Code Fragments

If you set your Wayback Machine to a little over 10 years ago, when the Macintosh was first introduced, you'll recall that the machine was delivered to the world with 128 KB of RAM. Although that was a respectable amount of RAM at that time, Mac engineers realized that an application would require more RAM than might be left free after the operating system had taken what it needed. They therefore designed the system so that applications consisted of relocatable chunks of code called *segments*. And, because of the limitation on the relative jump instruction within the 68000 CPU, the size of a segment was fixed at 32 KB. Although the operating system handled the headaches of loading and unloading segments, it was nonetheless left to the programmer to tell the Mac OS *when* a particular segment was free to be discarded (using the `UnloadSeg` trap).

With the introduction of Power Macs, what had been a code segment now becomes a code *fragment*. This is not, however, a simple change in nomenclature. Code fragments can extend beyond 32 KB, they can possess local data, and they carry named entry points. An application is really just a code fragment; when an application loads on a Power Mac, the Mac OS also loads all code fragments holding routines referenced by the application and binds the references (this is done by a new Toolbox service, the Code Fragment Manager). Code fragments are therefore very similar to dynamically linked libraries.

Note that the programmer no longer needs to get involved with memory management issues (i.e., which fragments are free to be unloaded). The reason for this, of course, is that the PowerPC has its own virtual MMU (memory management unit), so the entire mechanism for memory management moves into the operating system, where it belongs.

Mixed-Mode Programming

As I mentioned at the outset, Apple has done much work to make the transition to the PowerPC world as easy as possible. Specifically, Power Macs provide a 68K emulator that can make the machine look to the outside world like a 68020-based Mac. Actually, it looks sort of like a 68040 minus the 68040's integrated MMU and FPU. However, Apple discourages developers from presuming any instructions beyond those supported by the 68020.

This protects all the work that's been done to create the existing 68K code base. However, it would be crazy if the system

ran only in emulated fashion. Not only would that guarantee less-than-optimum performance, but no smooth transition to native PowerPC applications would be possible.

Apple engineers, looking at the Mac's Toolbox code, were staring at the same porting problems that any other Mac developer would be faced with during the transition. Not only would rewriting all that code take lots of time, programmers, and money, but the process would likely introduce bugs in routines that had long since been cleansed. So, Apple programmers rewrote only critical, often-called Toolbox routines in PowerPC code, leaving the rest in 68K code. These latter routines are executed by the Power Macs' 68K emulator.

Consequently, a given Toolbox routine might be written in PowerPC code, or it might be in 68K code (and therefore require the emulator). Since it would be unimaginable to place upon the programmer the job of determining—at run time—the machine-code type of a particular routine, Apple designed the Mixed Mode Manager and armed programmers with the UPP (Universal Procedure Pointer). It works as follows.

Any exported routine in a code fragment (i.e., a routine that can be called from outside the fragment) is accessed via a UPP. Setting up the UPP is the job of the caller (i.e., the caller calls the exported routine through the UPP). If the exported routine is composed of 68K code, then the UPP consists of just a typical pointer to the address of the routine's entry point. However, if the exported routine is composed of PowerPC code, the UPP is a data structure (called a *routine descriptor*), typically about 32 bytes in size, headed by a trap word that leads into the Mixed Mode Manager.

Consequently, calling the UPP either leads your program directly to the 68K code or transfers control to the Mixed Mode Manager. It is the Mixed Mode Manager's job to deduce where the application is coming from and where it's going to and to determine if a switch from native PowerPC code to the 68K emulator (or back) is needed. Note that this also requires moving arguments around (e.g., from registers to the stack) so that the called routine finds data where it expects it.

Happily, C/C++ compilers for PowerPC Macs already provide functions and macros that automate the process of building UPPs. Apple guidelines suggest that, wherever your code uses a `ProcPtr`, you replace it with a `UniversalProcPtr`.

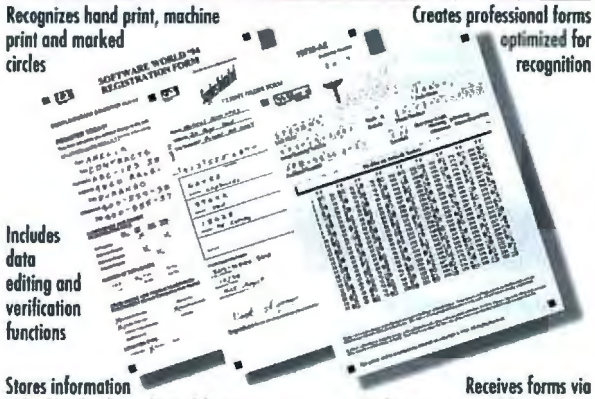
A Stroke of Genius

Faced with the admittedly daunting task of shepherding a well-established system into an entirely new processor architecture, Apple appears to be doing a remarkable job of accommodating developers during the transition. Admittedly, the transition isn't trouble-free; I have my own pile of C code that I'll have to sift through via search-and-replace and turn every `int` into `short`.

On the bright side, my opinion is that the Mixed Mode Manager (with its accompanying UPPs) is something of a stroke of genius. What it provides is a way for Apple to continue to move more of the Toolbox to native code, and programmers will see the benefits without having to make any alterations of their own.

Of course, it also means that as you target those routines that will yield the greatest performance if converted to PowerPC code, you'll be doing some code-tweaking for a while. But you're used to that, right? ■

Rick Grehan is technical director of the BYTE Lab. Before coming to BYTE, he worked as a programmer. He has a B.S. in physics and applied mathematics and an M.S. in mathematics/computer science. He can be reached on the Internet or BIX at rick_g@bix.com.

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Dear Reader—

The BYTE State of the Art section is devoted to delivering in-depth information about specific topics in computing on a monthly basis. In the November issue, the State of the Art section will cover the technologies and strategies involved in Network Management.

To ensure that our coverage is in tune with your needs, we request that you fill out the following questionnaire and fax it back to us. It will tell us about your installation and about your needs and interests and help us focus our coverage of Network Management to best address your concerns. Please take a few minutes to fill out this form and fax or mail a copy of it back to us.

Of course, questionnaires such as this are necessarily limiting. If you'd like to see other areas covered, or if you want to tell us your ideas about network management, please contact one of the SOTA section editors at the following E-mail addresses. Thank you.

Bob Ryan, b.ryan@bix.com
Russ Kay, russellk@bix.com
Scott Wallace, swallace@bix.com

Network Management

Describe your network:
(check all that apply)

- ☐ LAN with remote access
- ☐ single-segment homogeneous LAN
- ☐ multiple-segment homogeneous LAN
- ☐ mixed LAN environment (e.g., LocalTalk plus Ethernet)
- ☐ multiple homogeneous LANs linked via a WAN
- ☐ multiple heterogeneous LANs linked via a WAN
- ☐ multiple LANs connected via an SNA backbone
- ☐ other_____

Does your network include

- ☐ bridges?
- ☐ routers?
- ☐ concentrators/hubs?
- ☐ multiprotocol routers?
- ☐ multiplexers for external connections?

What protocols do you use?

- ☐ IPX/SPX
- ☐ TCP/IP
- ☐ NetBUI
- ☐ NetBIOS
- ☐ AppleTalk
- ☐ SNA
- ☐ DECnet
- ☐ other _____

Describe your WAN:

Bandwidth

- ☐ 56/64K
- ☐ fractional T1
- ☐ T1
- ☐ T3
- ☐ other_____

Connections

- ☐ dedicated point-to-point links
- ☐ public-access network
- ☐ on-demand connections (e.g., dial-up)

Technologies

- ☐ ISDN
- ☐ Switched-56
- ☐ Frame relay
- ☐ SMDS
- ☐ X.25
- ☐ ATM

Do you currently support SNMP?
yes____ no____

Do you plan to deploy SNMP?
yes____ no____

Are you investigating SNMP?
yes____ no____

Do you use an integrated management system, such as NetView or OpenView?
yes____ no____

If so, which one?_____

For the following, please rate each topic using this scale:

Not at all interested — Very interested
1 2 3 4 5

- ☐ Network administration tools
- ☐ Hierarchical storage management
- ☐ Configuration management
- ☐ Software/update distribution management
- ☐ Physical/electrical management
- ☐ Disaster recovery/backup
- ☐ Network management systems
- ☐ Security mangement

Comments:_____

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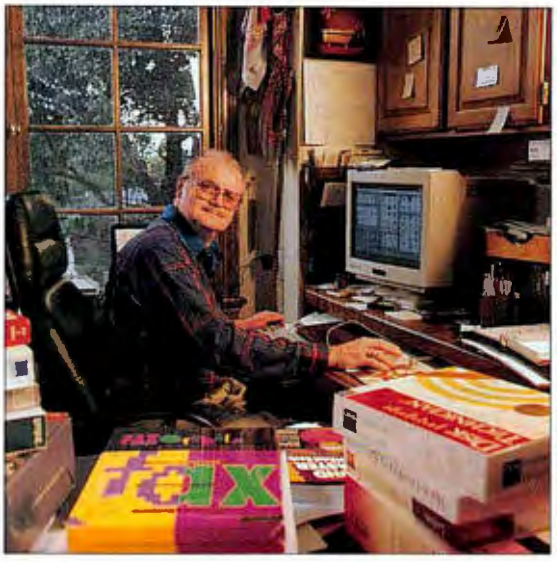
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JERRY POURNELLE

A Pentium Is Sounded Out



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Jerry names his new Pentium system, which he thrusts into the multimedia stream by testing several sound boards

We're just about recovered from the earthquake. Indeed, now that I've gotten rid of about 50 cubic feet of junk and sent more—including the 8-inch disks on which I wrote what appears to be the first novel ever written using a computer as a word processor—to storage, and have rebuilt my bookcases, the Great Hall is cleaner than it has been for five years; meaning that there's room for new stuff, and that wasn't long in arriving.

It's a lot of fun out here at the bleeding edge of technology, but it's not all roses. I've just spent three very long days getting a new Pentium system to behave. I'm not really complaining: I know there are a lot of young writers out there who'd love to trade places with me, and if I slow down, one of them may just be able to do it. Anyway, I learned a lot, and now you won't have to make the same mistakes I did.

It all started when Larry Aldridge became vice president of marketing for PC Power & Cooling. He wanted to build me a Pentium system to demonstrate just how well the PC Power & Cooling tower-configuration cases, power supplies, chip-cooling fans, and heat sensors can solve Pentium heat problems. Before it was over, he used a Micronics PCI (Peripheral Component Interconnect) motherboard, a really neat DEC DSP3107 1-GB SCSI hard drive, a Plextor Double Speed Plus CD-ROM drive (formerly the Texel CD-ROM drive), and a Distributed Processing Technology SmartCache SCSI caching hard drive controller that runs both the DEC hard drive and the Plextor CD-ROM drive. SmartCache will shortly run my Palindrome DAT (digital audiotape) drive and one or more optical drives. ATI Technologies contributed their Graphics Ultra Pro Mach 32 PCI video board. Larry put the basic system together and tested it before sending it on to me.

Our NEC MultiSync 4FG monitor was damaged a bit in the earthquake. Actually, the only real damage was to the swivel base. The monitor works just fine—we now use the fire ring for a wok as a base—but NEC sent a MultiSync 5FG to replace it. I connected that to the new Pentium system and got out one of my "Pournelle-configuration" Northgate keyboards, in my opinion still the best keyboard around. When I turned on the machine, the video came up, but nothing else happened.

I suppose I had a premonition, because I rolled out one of the heavy-duty worktables and laid the new tower-configuration machine on its side. Opening the computer revealed that the SCSI cable had disconnected from the controller, so it was no wonder the system didn't boot. Connecting the cable fixed that. The machine booted up fine with DOS 5, QEMM 6.03, and Windows 3.1. So far, so good.

There was no network card in the Pentium system, so I used Traveling Software's LapLink Remote Access for the initial file transfers. If you use LapLink to connect to a machine that is itself connected to any network, including Windows for Workgroups, you have access to the entire network. Even connected with a parallel cable, it's slow compared to Ethernet, but it does work, and I used it to bring over Norton Commander. I always do that first thing. There are, I suppose, other ways to edit, copy, rename, move, and delete files, but Commander's ability to

ILLUSTRATIONS: DIANA MINISCI APPLETON © 1994

look into odd-format files is pretty nifty, and the file finder is as good as any I know. Mostly, though, my fingers know Norton Commander down to the cellular level, and I'd be lost without it.

LapLink demands that you name the machine it's running on. I always do that anyway, and the new Pentium system has become Percival, as opposed to Percy, which is the IBM PS/2 Model 77.

Once I got Norton Commander up, it was time to install a sound board. Since everything was working fine, I hadn't bothered to sit down and read the documents that came with Percival. I just got out the sound boards and started in. That's when my education began.

The first thing I tried was a Creative Labs Sound Blaster 16 SCSI-2 board. Alas, when I turned on the machine, it wouldn't boot. I thought about that. The SmartCache controller has a SCSI connection, and the Sound Blaster board has a SCSI controller built onto it as well. Can two SCSI connections exist on one bus? If they can, can they both be addressed to the same SCSI address?

As it happens, the answer to both questions is yes. I ought to have known that, but for some odd reason I assumed the problem had to do with SCSI interference, and I looked for another sound board. The next one I found was a Sound Blaster Pro; alas, the board didn't say what model it was. The only identification on it was "CT-1600" written in the upper left corner. The machine came up fine with that, but all my Sound Blaster Pro software disks were destroyed in the earthquake. Since I wasn't sure what board I had, I tried the Sound Blaster 16 software. That's very well done stuff, but of course the software couldn't find the board. It offered to look at a variety of addresses with a number of interrupts, but it eventually reported failure.

Because the Sound Blaster Pro is last year's stuff anyway, I put in a call to Creative Labs to get a new Sound Blaster 16 board with the latest software. Then I looked through recent arrivals. Sure enough, we had a Logitech SoundMan 16 board. This actually incorporates two chip sets on one board: the 8-bit Creative Labs Sound Blaster–compatible chip set, and the 16-bit Media Vision chip set, called SoundMan 16. There are no jumpers on the SoundMan; it's all set up by software.

The installation requires two separate IRQ (interrupt request) lines, one for Sound Blaster and the other for SoundMan. Some older games demand a Sound Blaster at IRQ 5; the Logitech board offers a choice of 2, 3, 5, or 7, as well as three I/O port addresses. The SoundMan IRQ can be set to just about any value between 2 and 15. There are also choices of DMA channels between 0 and 7; you need two of those—one for Sound Blaster and one for SoundMan—with default values of 1 and 5, respectively.

DMA is a way for devices to send data directly to memory without funneling it through the CPU. DMA channels 0–3 are 8-bit; channels 4–7 were introduced with the IBM AT 16-bit bus and are 16-bit.

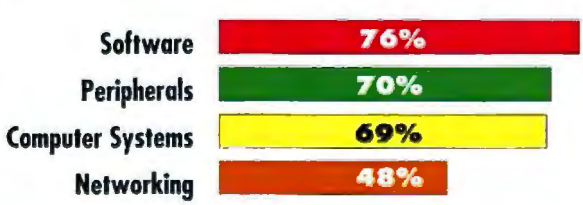
The SoundMan installation software performs a bunch of tests. Once you've chosen values that work, it offers to write them into your initialization files. I had to fiddle with some of the settings. In particular, DMA channel 1 was not working properly.

I called my friend Rich Heimlich. Rich tests games for a living. He also knows more about using sound boards than anyone I know and quite literally wrote the book on Sound Blaster boards. He said

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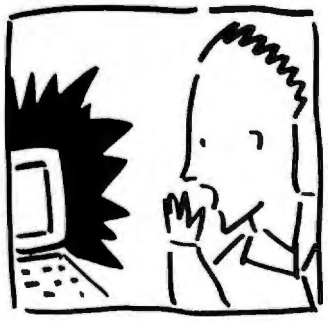
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that he had seen this problem before: some motherboards step all over DMA channel 1, apparently through cross talk on traces laid too close together. The remedy is to use a different DMA channel (generally 3), and, alas, some applications, including most older games, expect Sound Blaster on DMA channel 1 and can't use another.

This was worrisome. I called Aldridge, who called Micronics, and we soon had the answer: the Micronics motherboard lets you use either DMA channel 1 or 3 to connect to the parallel port. Doing that converts your port to a fast parallel port (for software that knows how to use it). This is highly desirable. More and more applications know how to make use of fast parallel ports, which are rapidly becoming a kind of poor man's Ethernet.



In assembling Percival, Aldridge had left the DMA channels floating free, and that, as it turns out, can generate noise in channels 1 and 3, which makes them unreliable. The remedy is to use jumpers to strap the parallel port to DMA channel 3. I did that, and Sound Blaster was able to use DMA channel 1 just fine. After that, I had no problems installing the SoundMan software.

Next step was to install an Intel EtherExpress card. Like SoundMan, the EtherExpress card has no jumpers; all settings are done with Intel's SoftSet software. The card requires an I/O port address and an IRQ, and those have to be different from the ones used by the sound board. SoftSet will try to find values not in use by anything else, but you can choose your own settings. Since nothing I know of uses IRQ 10, I set the network card to that. Then I installed Windows for Workgroups 3.11.

The easy way to do that is to create a disk directory called W4WG, copy all nine installation floppy disks to it, and then do a custom installation. This not only saves time, but W4WG can sometimes get so confused during installation that it forgets how to access floppy disks. However, it never forgets how to find a hard disk directory. The installation went smoothly enough, and everything worked just fine until Alex got home.

Alex has a sort of portable "Murphy" field: if something can break, he can break it. In this case, he found problems with the sound. A quick check showed why that wasn't working: the EtherExpress card was set to use IRQ 5, the same one as the Sound Blaster chip-set part of the SoundMan 16 board. I knew I had set that to IRQ 10, but then I remembered: W4WG likes IRQ 5 as the setting for the EtherExpress card, and when you install W4WG, it sets the card to that value no matter what value it finds it at. It doesn't bother to tell you it did that, either. In case you're wondering, this is a bug.

The remedy is to bring up Windows (use WIN /n to bring up W4WG without the network if the IRQ clash is so severe that it kills Windows), go into the Network window, open Network Settings, double-click on the Intel EtherExpress line in the menu, and set the IRQ to 10. You'll have to restart Windows, but this time the card will stay at IRQ 10.

We then started importing some sound effects—and achieved one of the most spectacular disk crashes I've ever seen.

It happened all at once. We were experimenting with MIDI wave sounds, and suddenly the C drive was filled with lost chains and cross-linked files. Pretty soon, one of the cross-linked files was COMMAND.COM, after which the machine would work only when booted from a floppy disk.

The DSP3107 hard drive is divided into two 500-MB logical drives. The D drive was fine, but the C drive was messed up beyond hope of repair. Sometimes you can get out of a bad situation with Norton Utilities, but this time the Norton programs were themselves cross-linked. There was nothing to do but reformat the hard disk, or at least the C drive.

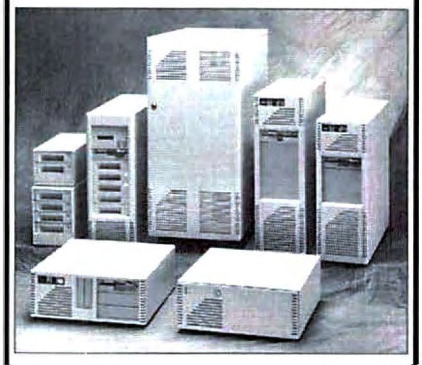
Unfortunately, even that didn't do it. We brought up the machine with a floppy disk that had FORMAT.COM on it, but when formatted with the /S qualifier, the C drive still wouldn't boot. It showed IO.SYS and COMMAND.COM as truncated. Oddly enough, though, using the SYS command took care of the situation. By now it was 4:00 a.m., and I went to bed.

Next morning I removed the sound board and completed the recovery. That didn't take long, because when I copied the W4WG floppy disks, I did it to the D drive. Once W4WG was running, it took almost no time to use the network to restore nearly everything to the C drive.

continued

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One thing I didn't restore was the version of QEMM that Larry had used in setting Percival up; that was just plain gone. On the other hand, I have a new copy of QEMM 7.03, so I installed that. It works just fine, yielding 600 KB for DOS and Windows without using QEMM Stealth. When everything is stable and backed up, it will be time enough to experiment with Stealth. For the moment, I don't have any programs that need more than 600 KB, and I'll leave well enough alone.

Actually, things didn't go quite as smoothly as I implied. For about an hour, I had more mysterious problems. Then I found out that my SmartCache controller was addressed to DC00, and if you don't tell QEMM to exclude DC00 to DEFF, the system can't possibly work. That done, though, everything was fine without the sound board.

Then I did what I should have done in the first place: read Percival's documents, particularly those having to do with the controller. It didn't take very long to see what the problem was.

SmartCache uses DMA to speed up disk reads. In particular, it uses DMA channel 5. The SoundMan board also uses DMA channel 5. When SoundMan put a wave sound onto channel 5 just as SmartCache did a write to disk, we wrote "Hail Columbia" all over the FAT (file allocation table). No wonder it crashed.

The simple remedy was to reinstall the SoundMan board and be very careful not to use DMA channel 5. With channel 3 strapped down to the parallel port, channel 1 worked just fine for Sound Blaster, and SoundMan had no problem with channel 7. We played around with enough MIDI wave sounds to be sure everything was working. No problems.

The Logitech SoundMan board works just fine, and it's compatible with both Media Vision's Pro Audio and Sound Blaster, as well as MIDI and various Windows sounds. We had the WindSurfer flopping about, and SoundMan comes with Icon Hear It, a way to associate sounds with different icons and Windows activities. Alas, there are problems, not with SoundMan, which works about as well as anything else, but with the whole multimedia sound business.

There are problems with cables. Every CD-ROM drive seems to have a different pin-out for internal audio output. At this point, I'd better explain for those just getting started.

Your CD-ROM drive is similar to the CD player in your stereo. Both can take recorded sound off a CD and send it to an

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amplifier or headphones. In addition, a CD-ROM drive can get digital data from a CD and move it to the computer bus; the computer translates that data into sound that you can hear. These two kinds of "recorded sound" are quite different, and they come out in different places.



Digital audio—like all other digital data—comes out of your CD-ROM player through the big, flat SCSI cable. It goes to your CD-ROM controller (which may be your sound board; in my case, the CD-ROM drive is on the same SCSI cable as my regular hard drive, and the controller is SmartCache). By contrast, standard audio comes out the front of your CD-ROM player; you can hear it by plugging in a stereo headset. In addition, every CD-ROM player has an audio connector on the back of the drive, and, with the proper cable, you can pipe that audio to the sound board so it can play it through the speakers.

Unfortunately, there are no standards for that internal audio, and every CD-ROM drive seems to use a different cable connector and pin-out. Most sound-board companies will sell you a cable if you tell them what model of their sound board you're using and what make of CD-ROM drive you have.

Of course, if you buy your sound board and CD-ROM drive as part of a kit (e.g., Creative Labs' Sound Blaster Digital Edge CD Multimedia Kit), you won't have that problem, because the internal cable will be included. That's one of the main advantages to buying such kits: everything works together.

In my case, SmartCache is faster than Sound Blaster, and the Plextor CD-ROM drive works well with it; and, of course, the controller gives me hardware caching on the controller. Understand, very few applications *need* that much speed or, indeed, can take advantage of it, so the Sound Blaster Digital Edge CD Multimedia Kit is plenty good enough for almost anyone and is one of the easiest ways to get both sound and a CD-ROM drive.

Anyway, I didn't have an internal cable; so I took a Radio Shack 6-foot stereo audio cable, plugged that into the earphone jack on the CD-ROM drive, and plugged the other end into the input jack (*not* the microphone jack) on the back of the SoundMan board. Later on, the same thing worked when we changed over to a Sound Blaster 16 board. When everything is stable, I'll get the right internal cable and connect things up, but for now the external cable works, and it's the only audio-cable standard in the business.

Once I was sure the SoundMan board worked, I wanted to try Creative Labs' Wave Blaster add-on board, because everyone tells me it's neat. My only problem was that when I put the Sound Blaster 16 board in, Percival wouldn't boot. All my Sound Blaster 16 boards have SCSI on them, and if there's any way to disable that, the documents don't tell me. There's also no way to change the SCSI address from whatever default it's set to. There is a way to readdress the SmartCache board from SCSI 7 to SCSI 6.

Fortunately, Alex got home before I did

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anything to the SmartCache board, because the SCSI ID is irrelevant; you can have two SCSI buses going at once, provided each has its own IRQ and DMA channel. The reason that Percival wouldn't come up with the Sound Blaster 16 board installed is that one function of that board defaults to DMA channel 5. As we've seen, SmartCache uses that, too.

That was when I got out the Distributed Processing Technology documents and studied everything. They're quite complete and clear enough. I found out that the controller uses memory address C800 by default, but it's set to DC00 on mine; it needs an I/O port address, and that can be 330h, an address the Sound Blaster 16 board defaults to; another place to be wary. The interrupt is set to IRQ 15, which is unlikely to be used by anything else.

Creative Labs provides complete instructions with diagrams on how to use jumpers to set all the various addresses, IRQs, and DMA channels on their Sound Blaster 16 board. One warning: it's in the thin document called *Getting Started* and is *not* repeated in the thicker *Reference Manual*; you should keep both. We used the manual to set the 16-bit DMA channel to 7 and otherwise used the defaults on the Sound Blaster 16 board. Those include a default to IRQ 5, the same as W4WG, and the MIDI port defaults to 330h, which might be in use by either the controller or the network card. I made sure those didn't interfere.

The machine came up just fine. Alex installed the Sound Blaster 16 software, including the Windows drivers. We made sure that all worked. Then we shut down and attached the Wave Blaster board. Wave Blaster piggybacks onto the Sound Blaster 16 board, and it does wonders for the sound. It has no settings; just attach it to the Sound Blaster 16 board.

With that in place, Mr. Spock really sounds like Mr. Spock, music has a brilliance it didn't formerly have, and it all sounds really nice, especially if you've got Creative Labs' Yamaha-designed Active Servo Technology speakers. These high-end speakers are about twice the size of the (actually very good) smaller speakers that come in the Sound Blaster Digital Edge CD Multimedia Kit, and if you care a lot about sound quality, they're worth the price. Of course, if you *really* care about sound quality, you'll feed the soundboard output into a regular stereo mixer, but that's going farther than I care to.

Next thing to look at was ATI Technologies' MediaMerge. This comes with an audio editor, a text editor to make text animations and flying logos, a scene editor, a storyboard editor, and a partridge in a pear tree. We've looked only at the audio editor. Alex used it to tune up the wave forms of various sound icons, add reverberations, clip sounds, and put in silence. He also tried to do some noise removal. This is as good as any wave editor he has seen, but note that he's not especially fond of any we have; none of them lets you change pitch, for example. He was able to put together some sounds so Mr. Spock can respond when the ingenue screams for help. More on that another time.

Alas, we're still getting anomalies. If you leave the system running with Berkeley Systems' After Dark with sound, after an interval that can be as short as 10 minutes and as long as 8 hours, the sound is messed up. Simple sounds work, but wave sounds are truncated or don't play at all. The only remedy is to power down the system. Neither Ctrl-Alt-Del nor hardware reset fixes it, and once I have the sound problem, I can't even cleanly exit W4WG.

I don't know why. My guess is drivers interacting with the Pentium, but whether it's Berkeley Systems' software or the Sound Blaster 16 driver isn't clear. It's certainly not a defective sound board; I've tried several Sound Blaster 16 and Wave Blaster boards, and I always get the same result. I'll keep looking, and I expect the problems will be fixed by the time you read this.

We've also had difficulty getting Word for Windows to print across the network. The symptoms are precisely the same as when we tried to get an OS/2 machine running OS/2 LAN Server to print through a W4WG network (see my April column). Because we were able to get a W4WG machine to print files through a printer attached to that OS/2 machine, I have to conclude that the guilty party is Print Manager, not OS/2.

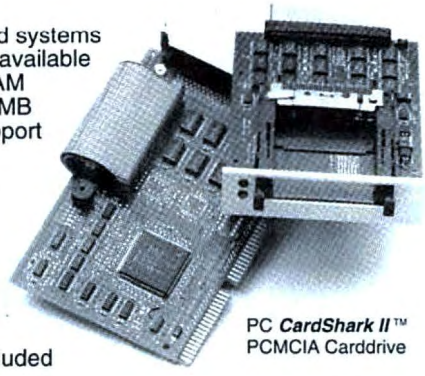
It's clearly the case that if I attach the printer to the OS/2 system, I have no problems printing from any machine on the network, while even without any OS/2 machines on the network, the best way to print through W4WG is to send the file across to the machine that has the printer, read it into Word, and print it locally.

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Another anomaly to look into. I'm sure it will be fixed when I learn the proper settings for the W4WG machines, but the fact is that OS/2 LAN Server seems to be more reliable when printing across a network than W4WG.

This mostly shows that we need a good Windows debugger. Windows is cool if you get everything set right, but no one really knows what's going on inside the .INI files. It's a pain to get Print Manager set up properly. Then, too, every now and then when Windows comes up, it reports that a group file has been clobbered. When that happens, you can replace the dead group file with a copy you've saved—and if you don't save copies of your group files in their own subdirectory, you'll one day wish you had—or you can painstakingly rebuild the group file by hand.



Actually, you'll need to do both. That is, you must go into the Windows subdirectory and delete the aberrant group file, come back to Program Manager and create a new group file, copy your saved group file into the Windows subdirectory, and restart Windows. With luck, that will solve the problem of a clobbered group file.

You have to do all this because Windows has no debugger and group files can't be edited by human beings. No one knows why. If someone knows of a good Windows debugger, please let me know.

By contrast, System Notebook (formerly ConfigWiz) from VacNat Software is a neat system-configuration editor for OS/2. OS/2 settings are done by means of a pop-up notebook, but, alas, IBM didn't provide one for figuring out the AUTOEXEC.BAT and CONFIG.SYS files.

System Notebook brings up multiple pages of a notebook and explains what changes you can make. When it's done, it saves it all as new OS/2 CONFIG.SYS and AUTOEXEC.BAT files. If you run OS/2, you need this. I wish the Windows people would come up with something as neat. Recommended.

We expect better Windows video drivers for the Pentium PCI bus. The best overall Win Tachometer performance of the Pentium PCI with ATI Technologies' Mach 32 PCI board has been 52, and we can nearly get that on the 486DX2/25 with a VL-Bus Mach 32 board. The fastest system in the house is still SuperCow, the Gateway 2000 486DX2/33 with a Hercules Dynamite Pro video board. Of course, a Win Tachometer rating over 50 is nothing to sneeze at; it wasn't all that long ago I was satisfied with machines that had ratings of 16 to 20. Now, anything under 30 seems intolerably slow. So it goes.

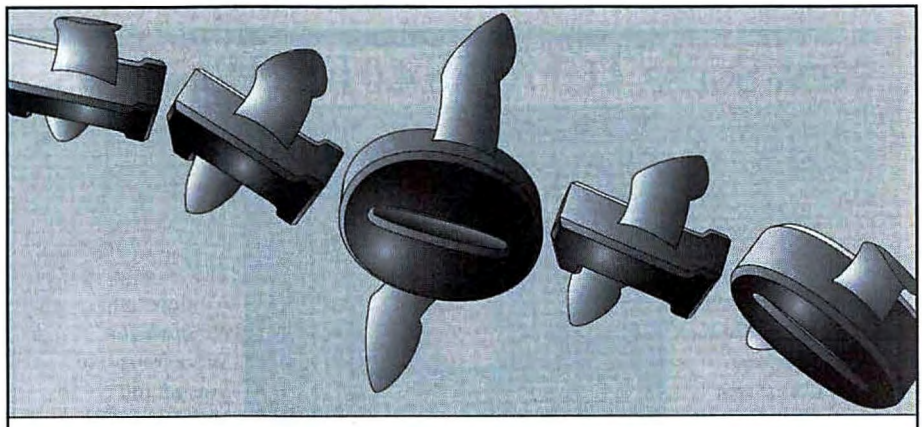
I have reports that Number Nine Computer has already solved the driver problem, and Number Nine PCI boards in Pentium machines are getting truly astonishing Win Tachometer results. We'll have one here soon, and I'll let you know.

While we're waiting for new drivers to take advantage of the Pentium's architecture, we shouldn't forget that the PowerPC chip is rushing upon us. Informants tell me that some software already runs faster on the PowerPC than on the Pentium; some of it *much* faster. All of which means that hardware has again leaped ahead of software, and, as the software people catch up, we'll see more spectacular improvements in what these machines can do. But by the time we get jaded with those new improvements, we'll have even-better hardware.

I can remember when a 10-MB hard drive cost several thousand dollars. CD-ROM drives used to be old and slow and cost a thousand dollars. The street price of my 1-GB DEC DSP3107 hard drive will be well under a grand when you read this, and CD-ROM drives cost less than 8-inch floppy drives used to. Ain't it wonderful?

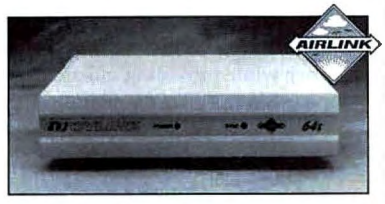
Despite residual glitches, I don't doubt that you can get a Pentium, ATI Technologies' Graphics Ultra Pro Mach 32 PCI board, and Sound Blaster/Wave Blaster sound boards working together; mine does most of the time, the only problems being with wave sounds in W4WG. The Pentium should be a real killer of a flight simulator and a truly awesome games machine; which means that as the right software is developed, it will also be excellent for desktop conferencing, multimedia, and that sort of thing. At least that's what you can tell your boss when you say you have to have one.

One multimedia package we looked at was part of Microsoft's newest Home (as opposed to Office) series, Multimedia Schubert 1.0. This product group also includes Mozart and Stravinsky. It's built



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around the Quintet in A Major (*The Trout*). Like the rest of this series, it's really well done, with background information on the composer and his times, and a music discussion that starts simple and gets as technical as I want. I find these really do add to musical enjoyment, and I recommend the series for anyone who is or might want to become interested in classical music.

I have about a zillion other multimedia programs, including Grolier's and Compton's encyclopedias. I suppose I should come up with some way to choose one multimedia program over another, but the fact is they're all good and getting better. If you don't have one of them, you should; there's no point in waiting for better, not that better multimedia packages won't be here soon enough. Really good whizbang sound boards are coming this year, but what we already have is darned good, too.

My advice is to get what's out there. For instance the combination of the Sound Blaster Digital Edge CD Multimedia Kit, a Sound Blaster 16 board with a Wave Blaster add-on board, and a good double- or triple-speed CD-ROM drive is already good enough and will last you the year or so that it takes to perfect the new stuff that's coming later this year. If you keep waiting for the best, you'll miss out on everything.

The Macintosh version of Roberta Pournelle's reading program, The Literacy Connection, is done. She'll be doing the grand introduction at her session of the International Conference on Technology in Education in London later this month.

This version was done in SuperCard. The programmer, Chris Innanen, used the QuickBasic code I did in the mid-1980s and began to convert that to HyperCard. Roberta then decided she wanted a color version, which required that they switch to Silicon Beach's SuperCard. SuperCard was then bought by Aldus and now has been sold to Allegiant Technologies. SuperCard is HyperCard on steroids. The basics are fairly easily learned.

As Roberta's program shows, you can do some pretty complex programs in SuperCard, but that requires actual programming. HyperCard and SuperCard are still the best ways to get involved in Mac programming. Chris reports that if the newest version of HyperCard had been available, he would probably have done the program in that, but the advantages of HyperCard II over SuperCard aren't so great that he's going to convert.

The result is a script-driven engine that lets Roberta change the lesson plans without extensive programming. I've talked

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about The Literacy Connection before. Like the PC version, the Mac version requires a literate person to read the screens to the student, but the "instructor" doesn't have to be a teacher because all the instructions are at fourth-grade level. In one school, a 10-year-old uses the program on an Osborne luggable to teach reading to first-graders. The next version of The Literacy Connection should be self-pronouncing and thus do away with the need for an instructor.

We don't know of anyone who has gone through all 70 lessons and emerged unable to read English; we know it has worked with many students diagnosed as dyslexic or learning-disabled, as well as with normal and gifted students. It unabashedly teaches systematic phonics. In our judgment, to be able to read implies the ability to read any English word, whether or not you have seen it before, thus instantly making your reading and speaking vocabulary identical.

The Mac version is much changed from the PC version I programmed several years ago. It has color and animations. Unlike much software that tries to be educational, The Literacy Connection is not a game. An upcoming version will incorporate a game as a reward for getting the lesson right. Kids who've seen the test version of the game go bonkers for it, but it's still the case that games are more to impress publishers and parents than kids; children find that actually learning to read is a pretty rewarding experience all by itself.

We've had a fairly hefty demand for an Apple II version of The Literacy Connection. Now that schools are converting those Apple IIs to Macs, the pressure has been on to get a Mac version done, and Roberta regrets that it took a lot longer than she thought it would. She's polishing up the manual as I write this.

I know I write about her program a lot, but it is my considered opinion that she's got the best reading instruction program in existence; and if kids can't read, they aren't going to learn much else in school. Anyway, this is available, it works, and I'm proud to be able to recommend it.

I was hoping the game of the month would be SimCity 2000 by Maxis, but I can't seem to install the DOS version. This is twice now, but I'll keep trying. Meanwhile, I've gone back to an ancient game called Sword of Aragon from SSI. It still plays well. Another old-timer I like is QQP's Battles of Destiny.

Maxis also publishes SimHealth, which is a model of health care. Like all models,

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many of the conclusions are built into the model's assumptions. This is an excellent tool to stimulate discussion; the danger lies in using such simulations as real models of the real world. With that caveat, I can recommend the program to those interested in health-care policy.

The book of the month is by Richard E. Cytowic, M.D., *The Man Who Tasted Shapes* (Tarcher/Putnam, 1993). You may never have heard of synesthesia, a sort of scrambling of senses that might cause you to smell in colors or, as the title suggests, taste shapes; but it's very real, and this entertaining book tells of some experiences the author has had with such people, using their experiences to inquire into the nature of sensation and perception. I guess that sounds more like a book reviewer than me, which means I'm getting tired. Anyway, you'll like the book. The most useful computer book this month was Brian Livingston's *Windows 3.1 Secrets* (InfoWorld Technical Books, 1992).

Next month: more on Percival. With luck, we'll get him running NextStep, OS/2, and Windows NT so we can do some comparisons. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at jerryp@bix.com.

For More Information

Available now for the Mac, **The Literacy Connection** ($100 postpaid, California residents add $8.25 state tax) is the best reading instruction program in existence. Contact **The Literacy Connection,** 12190½ Ventura Blvd., Suite 372, Studio City, CA 91604. **Circle 1146 on Inquiry Card.**

ATI Technologies' **MediaMerge** ($299) multimedia editor for sound, text, and graphics is as good as any editor we've seen. Contact **ATI Technologies, Inc.,** 33 Commerce Valley Dr. E, Thornhill, Ontario, Canada L3T 7N6, (905) 882-2600; fax (905) 882-2620. **Circle 1147.**

Microsoft's **Multimedia Schubert 1.0** ($79.95) really does add to musical enjoyment. Contact **Microsoft Corp.,** 1 Microsoft Way, Redmond, WA 98052, (800) 426-9400 or (206) 882-8080; fax (206) 883-8101. **Circle 1148.**

The **Plextor Double Speed Plus** ($329) CD-ROM drive works well with my multimedia system configuration. Contact **Plextor,** 4255 Burton Dr., Santa Clara, CA 95054, (800) 886-3935 or (408) 980-1838; fax (408) 986-1010. **Circle 1149.**

SimHealth ($39.95), a model of health care, is an excellent tool to stimulate discussion for those interested in health-care policy. Contact **Maxis,** 2 Theater Sq., Orinda, CA 94563, (800) 336-2947 or (510) 254-9700; fax (510) 253-3736. **Circle 1150.**

SmartCache III SCSI host adapters (from $285 to $595) are a family of solid, trouble-free SCSI caching hard drive controllers. Contact **Distributed Processing Technology,** 140 Cadence Dr., Maitland, FL 32751, (800) 322-4378 or (407) 830-5522; fax (407) 260-5366. **Circle 1151.**

The Creative Labs multimedia sound boards tested on my Pentium system include the **Sound Blaster 16 SCSI-2** ($279.95), the **Sound Blaster Pro Deluxe** ($179.95), and the **Wave Blaster** ($249.95). Contact **Creative Labs,** 1901 McCarthy Blvd., Milpitas, CA 95035, (800) 998-5227 or (408) 428-6600; fax (408) 428-6611. **Circle 1152.**

Logitech's **SoundMan 16** ($199) sound board works just fine on my Pentium system. Contact **Logitech,** 6505 Kaiser Dr., Fremont, CA 94555, (800) 231-7717 or (510) 795-8500; fax (800) 732-3102. **Circle 1153.**

With **SuperCard** ($299), you can do some pretty complex programs on the Mac. Contact **Allegiant Technologies,** 6496 Weathers Place, Suite 100, San Diego, CA 92121, (619) 587-0500; fax (619) 587-1314. **Circle 1154.**

System Notebook ($24 postpaid) is a neat system-configuration editor for OS/2. If you run OS/2, you need this. Contact **VacNat Software,** 1370 White Oak St., Harrisonville, MO 64701, (816) 887-2928. **Circle 1155.**

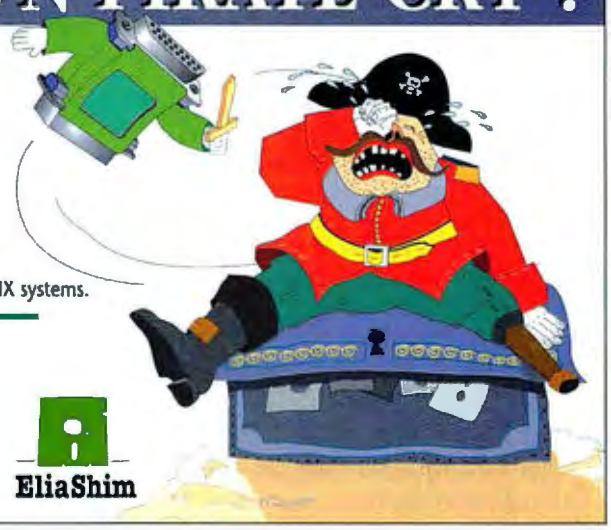
PC Power & Cooling demonstrated their high-end PC cooling technology by building a Pentium system, which included a **tower case** ($349), a **line-conditioning power supply** ($229), the **Pentacool** ($39), and the **110 Alert Plus** ($49). Contact **PC Power & Cooling, Inc.,** 5995 Avenida Encinas, Carlsbad, CA 92008, (800) 722-6555 or (619) 931-5700; fax (619) 931-6988. **Circle 1156.**

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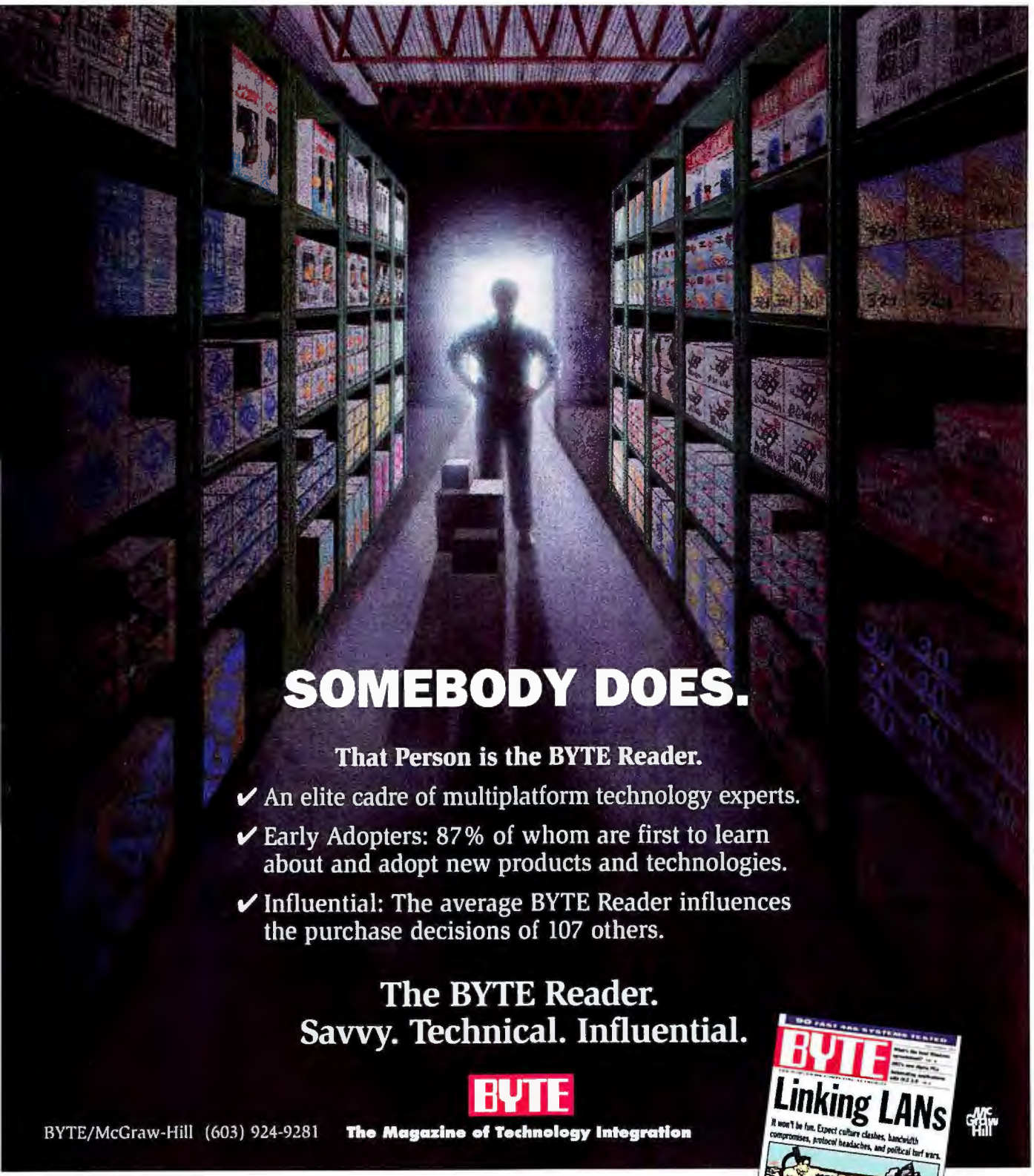
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What's New Hardware



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The InterActive Communicator system includes a 33-MHz 486 processor, 4 MB of RAM, and a 200-MB hard drive. The voice-recognition software runs under Windows and DOS. Available options include a hand scanner, a video-capture board, an Ethernet card, and a CD-ROM drive. The base system is $2995.

Contact: InterActive, Humboldt, SD, (800) 266-4333 or (605) 363-5117.

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The Rememory Archiving Sub-Server (from $3195) lets you convert a host 386 or 486 PC into a nondedicated, full NetWare archiving server that backs up, archives, and provides disaster recovery of data. From Rememory (Costa Mesa, CA), the integrated, preconfigured desktop system has a 170-MB hard drive that is preinstalled with the RemServe archiving software system and NetWare; one or two DAT drives for up to 8 GB of storage; and a 16-bit ISA or 32-bit EISA SCSI controller.

Phone: (800) 644-2300 or (714) 708-0990.

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CREATE A LAN WITHOUT A MAU ▼

The NCI Banc-Ring 16/4 adapter ($595) lets you create an inexpensive small- to medium-size MAU-less LAN using standard token-ring cables. From Network Controls International (Charlotte, NC), the bus-master adapter is configurable for 4 or 16 Mbps and uses STP, UTP, or B-loop cabling. You can disable the MAU-less feature to connect the adapter to any IBM-compatible MAU. The adapter also has a $150 option that you can add to electronically disable the PC's floppy drive as a way to protect against viruses and unauthorized removal of sensitive information from the network.

Phone: (704) 527-4357.

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A whiteboard that uses standard dry-erase markers and erasers, the Smart WriteBoard ($2995) automatically transfers information written on it to your PC or Sun SparcStation via the serial port. You can store the information as a bit-mapped file and save it, print it, or incorporate it into other documents or presentations. The Smart Pen Tray has built-in switches that recognize the color of the pen you select and communicate this information to your computer; the proper color then shows up on the monitor's screen. The Smart WriteBoard is from Smart Technologies (Calgary, Alberta, Canada).

Phone: (403) 233-9333.

Circle 1316 on Inquiry Card.

MULTICHANNEL DSP BOARD

A board combining a DSP32C 32-bit floating-point DSP and eight channels of analog I/O, the Sig32C-8 ($3995) from Signalogic (Dallas, TX) is packaged with the company's Hypersignal-Macro and Hypersignal-Acoustic software. Each I/O channel contains 16-bit sigma-delta A/D and D/A converters and programmable input gain, output attenuation, and sampling rate. The channels also have automatic antialiasing and reconstruction filters that track with the programmed sampling rate. Sampling is simultaneous.

Phone: (214) 343-0069.

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COMPACT CONNECTORS AND PROTECTORS

A 2-ounce network connector for Macintoshes and other devices with built-in Ethernet, EasyNet ($69) connects any device with an Apple Ethernet port to either 10Base-T or 10Base-2 network cables. The Dayna Communications (Salt Lake City, UT) connectors have a BNC interface or an RJ-45 jack.

Phone: (801) 269-7200.

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The Connector Protector attaches to any DB-9 ($4.85 for 25) or DB-25 ($5.15 for 25) connector with jackscrews to take the brunt of the mechanical wear incurred by frequently connecting and disconnecting cables to computer boards. The unit is from CAMI Research (Lexington, MA).

Phone: (617) 860-9137.

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ENCRYPTION MODEM

The CryptoCom V.32bis asynchronous pocket modem ($895) from Western Datacom (Westlake, OH) encrypts all data transmissions between two of the company's encryption modems. The CryptoCom has a base data rate of 14.4 Kbps and uses up to level-10 MNP for data compression and error control. When two CryptoCom V.32bis modems are used together, they can encrypt cellular data. You can use the modem in nonencrypting applications in which you use V.42bis for data compression; the compressed data rates can exceed 56 Kbps in these applications.

Phone: (800) 262-3311 or (216) 835-1510.

Circle 1320 on Inquiry Card.

MANAGED HUB MONITORS NETWORKS

The InterLanLink series of stackable Ethernet hubs (from $1699) are available in 17- and 33-port versions. You can connect them in any combination for a maximum of 96 managed 10Base-T ports in a single repeater stack. From Racal InterLan (Boxborough, MA), the hubs feature FaultAlert, which monitors the network and alerts the network manager of any potential problems by sending a warning message to the management terminal that's attached to the RS-232 connection. When the terminal is remotely located, the hub automatically dials the configured phone number and sends a message describing the fault condition and its location.

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Contact: OCTus, San Diego, CA, (800) 634-8248 or (619) 452-9400.

Circle 1312 on Inquiry Card.

AUDIO/VIDEO CAPTURE BOARD

The MovieMan video- and audio-capture board ($299) captures 24-bit-color video with synchronized sound at 30 frames per second. The Logitech (Fremont, CA) board supports NTSC and PAL analog signals and the DVCI (Digital Video Connector Interface) digital-video interface standard. MovieMan also captures still images in resolutions of up to 640 by 480 pixels in 24-bit color and supports CD-ROM multimedia via Video for Windows and audio .WAV files.

Phone: (510) 795-8500.

Circle 1322 on Inquiry Card.

CAPTURE SCIENTIFIC IMAGES ON YOUR MAC ▼

A scientific imaging system for the Mac, the Image Explorer ($6000) captures and analyzes gray-scale image data in both bright light and low light. Intended for applications such as microscopy, fluorescence in situ hybridization, chemiluminescence, and gel documentation, the Image Explorer achieves the range of light sensitivity by integrating image data on-chip at video rates. The package's frame grabber can grab a video sequence of up to 32 frames in real time; optional memory modules allow up to 4 seconds of real-time image-sequence capture. The product is from Signal Analytics (Vienna, VA).

Phone: (703) 281-3277.

Circle 1321 on Inquiry Card.



WORKSTATION POWER

The 100-MHz Model VL-4100 DX4 workstation (enhanced version, $2995) includes a 9.8-ms 12-MBps Mode 3 540-MB IDE drive, 16 MB of RAM, a dual-speed CD-ROM, and a 15-inch low-radiation monitor. The CPU in the Tangent (Burlingame, CA) unit runs at 3.3 V; the on-board integrated I/O features UART high-speed serial ports and eight expansion slots. Windows for Workgroups and DOS 6.2 are standard, as are a FlashROM BIOS, a frequency synthesizer, Energy Star compliance, and upgradability to the Pentium P24T processor.

Phone: (800) 800-6060 or (415) 342-9388.

Circle 1323 on Inquiry Card.

FAST NETWORKING

The EM960 PCI eMaster+ series Ethernet adapter ($249) uses the full 132-MBps transfer rate allowed by the PCI specification. From Cogent Data Technologies (Friday Harbor, WA), the adapter incorporates the company's Predictive Pipelining technology to increase network bandwidth by minimizing processing overhead. According to Cogent, the full-duplex Ethernet capabilities of the EM960 PCI adapter can double the existing 10Base-T bandwidth to 20 MBps.

Phone: (800) 426-4368 or (206) 378-2929.

Circle 1324 on Inquiry Card.

PORTABLE DATA ACQUISITION SYSTEM

The Windows-compatible, four-channel MicroDataLogger unit (starter kit, $1195) operates from either a rechargeable battery or external power. From Architectural Energy (Boulder, CO), the microprocessor/flash-memory recorder is self-configuring, accepts interchangeable sensors, and records up to 64,000 measurements. It has an LCD and 12-bit resolution. The unit is capable of HVAC diagnostics and commissioning, utility DSM program evaluation, and environmental monitoring.

Phone: (800) 450-4454 or (303) 444-4149.

Circle 1325 on Inquiry Card.

VOYAGE INTO VIDEO CACHING

A 32-bit VL-Bus video adapter with video caching, the Boca Voyager (from $245) provides fast video performance while using DRAM video memory. The Boca Research (Boca Raton, FL) board, designed for peak performance with multimedia applications and CD-ROM video, includes 32-bit memory access, 1 MB of DRAM (upgradable to 2 MB), 15-/16-bit high color and 24-bit true color, a VESA BIOS, linear driver support, BitBlt, a hardware graphics cursor, and a feature connector.

Phone: (407) 997-6227.

Circle 1334 on Inquiry Card.

LIGHTWEIGHT HEAVYWEIGHT

Based on its proprietary DSP-based data-pump technology, the U.S. Robotics (Skokie, IL) portable WorldPort Dual Standard Fax modem (from $545) comes with a 9-pin cable and includes the company's HST protocol to provide 16.8-Kbps data transmission. The modem also has Adaptive Speed Leveling and Quick Connect features, as well as Class 2 fax capabilities, V.42/MNP 2–4 error control, and V.42bis/MNP 5 data compression.

Phone: (708) 982-5010.

Circle 1326 on Inquiry Card.

SMART POWER MANAGEMENT

A power management device that plugs into a serial port on your computer, the SmartSocket+ ($349) puts switching of AC outlets under software control. From CompuSci (Fenton, MO), the device automatically powers down AC receptacles when it receives an external alarm. The configuration of the device is saved in nonvolatile memory for use at power-up. Password protection lets you access the SmartSocket+ via a modem to switch remote devices on or off.

Phone: (314) 343-5022.

Circle 1327 on Inquiry Card.

REMOVABLE-CARTRIDGE GUARD

SyGuard ($8.99) is a dust and contamination guard designed to prolong the mechanism life of the SyQuest 44, 88, and 88C removable-cartridge drive systems. Made of rugged plastic, the APS Technologies (Kansas City, MO) guard is fitted with a precision gasket lock that fits most SyQuest mechanisms.

Phone: (800) 235-2753 or (816) 483-6100.

Circle 1328 on Inquiry Card.

What's New Hardware



TAKE DAT STORAGE WITH YOU

DAT storage subsystems that operate via your portable computer's parallel printer port or SCSI connection, the PDS-2 ($2995) and the PDS-4 ($3295) provide 2 and 4 GB, respectively, of data storage. From Parallel Storage Solutions (Elmsford, NY), each subsystem can double its capacity via data compression. Transfer rates using the parallel port are 6 to 17 MB per minute; SCSI connections provide a transfer rate as high as 44 MB per minute. The units are compatible with DOS, Windows, NetWare, LANtastic, OS/2, SCO Unix, and SCO Xenix.

Phone: (914) 347-7044.

Circle 1329 on Inquiry Card.

A MONITOR FOR WORKSTATIONS

The 17-inch Multigraph 447X monitor ($1250) from Nokia Display Products (Sausalito, CA) features an antiglare-coated Trinitron tube with a 0.26mm aperture grill. Manufactured in Finland, the monitor has a resolution that ranges from 1280 by 1024 pixels at a 75-Hz refresh rate to 1600 by 1200 pixels at a 60-Hz refresh rate and a horizontal frequency range of 30 to 82 kHz. An intuitive on-screen menu makes adjustment easy, and the unit automatically synchronizes with any desktop computer, according to Nokia. The unit complies with the VESA DPMS power-saver specification and the MPR II standard and includes a Mac adapter.

Phone: (800) 296-6542 or (415) 331-0322.

Circle 1333 on Inquiry Card.

SHUTTLE YOUR DATA OFF YOUR NOTEBOOK

The Disk Shuttle (from $417) from Computer Connections



America (Bedford, MA) is a 2½-inch portable hard drive that you connect to your parallel port for additional storage, file transfer, and backups. Storage capacity ranges from 170 to 344 MB, and access time is 12 ms. To use your printer with your notebook, you just plug in the printer cable to the opposite end of the Disk Shuttle unit.

Phone: (800) 438-5336 or (617) 271-0444.

Circle 1330 on Inquiry Card.

CD-ROM NOTEBOOK

The top-of-the-line Hurricane notebook ($8355) includes an internal 5¼-inch CD-ROM drive, a sound chip on the motherboard, a 540-MB IDE removable hard drive, 20 MB of RAM, and a 66-MHz 486DX2/SL CPU. The active-matrix 10-inch color display has 256 colors; you can have simultaneous displays at resolutions of 640 by 480 pixels on the notebook and 1024 by 768 pixels on an external monitor. The Aquiline (Troy, NY) Hurricane also has voice recognition and a PCMCIA Type II card slot, a built-in trackball, and a battery life of 3 hours.

Phone: (518) 272-0421.

Circle 1335 on Inquiry Card.

SOUND CARD WITH SPEECH RECOGNITION

A sound card with built-in wavetable synthesis and a DSP, the Aria 16se ($169) has 16-bit digital-audio playback and recording and a 44.1-kHz sampling rate. The card's Aria Listener Speech Recognition uses speaker-independent technology, which lets it recognize most words in its vocabulary regardless of who says them, according to Prometheus Products (Tualatin, OR). The card also lets you create customized vocabularies and has a SCSI-2 connection that supports CD-ROM drives from a variety of manufacturers.

Phone: (503) 692-9600.

Circle 1336 on Inquiry Card.

CURSOR CONTROL THAT FITS IN YOUR HAND



An interactive hand-held controller that fits in your hand, the ProPoint ($129) has a pressure-sensitive button that provides 360-degree cursor control at the touch of a thumb. You can select thumb-controlled cursor speed from a continuous range and select objects such as menus with a point-and-click motion. From Interlink Electronics (Camarillo, CA), the ProPoint has a 12-foot cord to allow you freedom during presentations.

Phone: (805) 484-8855.

Circle 1332 on Inquiry Card.

IMAGE-PROCESSING POWER

Designed for use with image-processing, vision, and robotics systems based on the TMS320C40, the HETVIO 8-bit image-processing TIM-40 module ($6750) features a PAL/NTSC frame-capture interface that supports up to four multiplexed camera inputs. From Traquair Data Systems (Ithaca, NY), the card supports the continuous and concurrent capture, processing, and display of frame-rate image data via its 1-MB triple-ported VRAM frame store. It also has 4 MB of local DRAM, a 4-bit overlay plane, and enhanced support for byte-level manipulation of image data.

Phone: (607) 272-4417.

Circle 1337 on Inquiry Card.

FAST COLOR PRINTING

The 2-ppm Spectra-Star GTx ($4995) plain-paper color printer uses a RISC processor running at 33 MHz. The printer features 10 MB of RAM (expandable to 32 MB), 52 fonts, 600- by 300-dpi printing, and the ability to accept plug-in cartridges via Pockettes. A 120-MB hard disk cartridge with full printer spooling and permanent font storage is available.

Contact: General Parametrics, Berkeley, CA, (510) 524-3950.

Circle 1313 on Inquiry Card.



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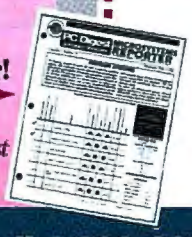
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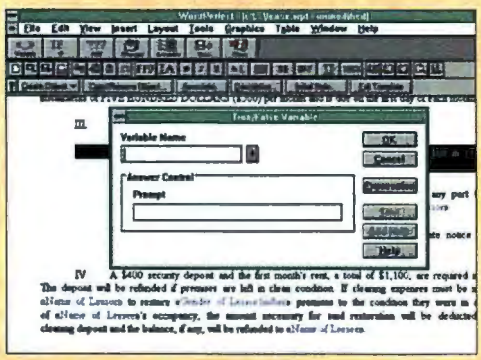


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Circle 113 on Inquiry Card (RESELLERS: 114).

What's New Software



Build a Template, Click a Button, Create a Document

Now you can build document-assembly templates in WordPerfect, Ami Pro, and Microsoft Word without having to write macros. With HotDocs, you simply open a document; highlight a name, date, or other text that frequently changes from document to document; and insert a variable for each highlighted choice. To assemble a document using the template, you click on a button, whereupon the template asks questions based on the variables you've defined. In response to your answers, appropriate paragraphs are automatically selected, and variables such as names, dates, pronouns, and verbs are correctly inserted. HotDocs retails for $49.

Contact: Capsoft Development, Provo, UT, (800) 500-3627 or (801) 375-6562.

Circle 1271 on Inquiry Card.

REMOTE CONTROL AND ACCESS

CoSession for Windows (two-PC package, $199) supports enhanced background operations, multiple connections, and remote operation of DOS and Windows programs. Compression technology in the software provides 30 percent faster remote Windows operation, according to the manufacturer, Triton Technologies (Iselin, NJ). Remote access capability, implemented through drive redirection, allows a remote user connected to a networked host to operate as a remote node on the network.

Phone: (800) 322-9440 or (908) 855-9440.

Circle 1276 on Inquiry Card.

FAX FROM WINDOWS

The FaxFacts FFWIN utility (from $300) lets you fax directly from any Windows application when you use it with FaxFacts broadcast software, a high-performance fax board, and a dedicated PC that acts as a fax server tied to the network for outbound-only faxing. From Copia International (Wheaton, IL), the FFWIN utility is compatible with all networks and allows for pre- and post-process activities, such as E-mail notification.

Phone: (800) 689-8898 or (708) 682-8898.

Circle 1279 on Inquiry Card.

3-D IMAGES FOR ANY PRINTER ▼

RenderPrint ($249) lets you print photo-realistic 3-D images from any graphics application on any printer at full printer resolution. From Insight Development (San Ramon, CA), RenderPrint can convert to and from most popular file formats, such as BMP, GIF, JPEG, PCX, and TIFF. The software works in ADI protected mode within AutoCAD and other ADI-supported applications; as a TSR program that pops up inside Cadkey, MicroStation, and other graphics programs; and as a stand-alone application.



Phone: (800) 825-4115 or (510) 244-2000.

Circle 1275 on Inquiry Card.

GRAPHICS THAT SAVE MONEY

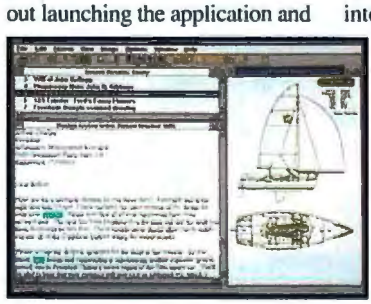
ActiGraf ($795) helps you spot wasted costs and inefficiencies by graphically depicting company policies and procedures. The software divides company operations into microsteps so that everyone involved can easily identify and understand each phase of every procedure. From Business Modelling Systems (Los Altos, CA), ActiGraf lets you dynamically analyze procedures via its ability to run a model to show how a process will behave and how long it will take to execute in a given set of business conditions.

Phone: (415) 941-3901.

Circle 1277 on Inquiry Card.

PUT YOUR DATA ON CD ▼

Alchemy ($995) from IMR (Englewood, CO) enables you to work alone or in a workgroup to collect text and image files in their native formats for transfer to a CD. You can organize the files into folders, index each file by full text or keywords, and then copy the indexed files to a CD by using any industry-standard CD recorder. Any user who has a CD-ROM drive can search by full text or Query-by-Example to find any file in less than 3 seconds, according to the company. You can view a file without launching the application and then print the file or copy it to a local directory.



Phone: (303) 689-0022.

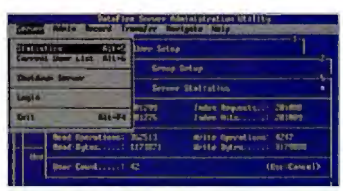
Circle 1278 on Inquiry Card.

SYSTEM ANALYSIS AND TROUBLESHOOTING

PC diagnostic and troubleshooting software, QuickTech-Pro ($249) from Ultra-X (Santa Clara, CA) has a main menu for quick access to all test groups. You can test all memory, cache, and VRAM up to 4 MB. You can test floppy and hard drives, perform system burn-in, test serial and parallel ports to pin level, and test functionality of interrupts, DMAs, keyboards, and mouse operations. You can also run CPU-speed, system, video, and hard drive benchmarks.

Phone: (800) 722-3789 or (408) 988-4721.

Circle 1280 on Inquiry Card.

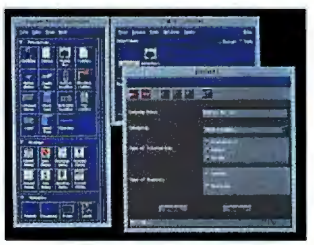


CLIENT/SERVER AND 4GL WORK TOGETHER ▲

The DataFlex Server Edition (from $1995) provides client/server computing for the DataFlex object-oriented fourth-generation language. The software, from Data Access (Miami, FL), allows multiple clients using different environments, such as DOS and SCO Xenix, to be attached to the same server. Features include transaction logging by the server for increased data integrity, user password protection for complete data security, transaction processing by the server for improved data reliability, and tunable system parameters for optimized system performance.

Phone: (800) 451-3539 or (305) 238-0012.

Circle 1281 on Inquiry Card.



OBJECT-ORIENTED TOOLKIT FOR MULTIPLE PLATFORMS

An add-on to the UIM/X development tool for OSF/Motif, Cross Platform Toolset ($2500) provides the objects, libraries, and documentation necessary to create production-quality applications for use on multiple platforms. Based on native toolkit controls, the tool set lets the ported application interface look and behave like a native one and provides for the inclusion of platform-specific capabilities. You can use object-oriented programming techniques to build GUIs from reusable portions of code that encapsulate any platform-specific application code, and you can implement objects using many third-party packages. The package is from Visual Edge Software (Saint-Laurent, Quebec, Canada).
Phone: (514) 332-6430.
Circle 1282 on Inquiry Card.

SIGN ON IN WINDOWS

Designed for use with a digitizer tablet or pen-based computer, Sign-On Verify ($395) from Sign-On Systems (Beverly Hills, CA) allows a person's signature to be used in place of a log-in and password or PIN. Targeted as a security add-on to applications and currently available for use with FoxPro, Paradox, Visual Basic, and C, SOV provides developers with the ability to prompt users for their signatures and verify that a signature is not a forgery. The SOV software employs Communication Intelligence's Dynamic Signature Verification technology.
Phone: (310) 274-7477.
Circle 1283 on Inquiry Card.

SWIM WITH UNIX

Swim ($149), a run-time and development system based on OSF/Motif 1.2.3, is available for Unix platforms such as Linux, Coherent, and BSD/386. From Sequoia International (Deerfield Beach, FL), Swim includes the mwm window manager, static libraries, header and include files, complete on-line manual pages, and source code to the OSF/Motif demo programs.
Phone: (305) 480-6118.
Circle 1284 on Inquiry Card.

GREASE THE SWITCH IN WINDOWS

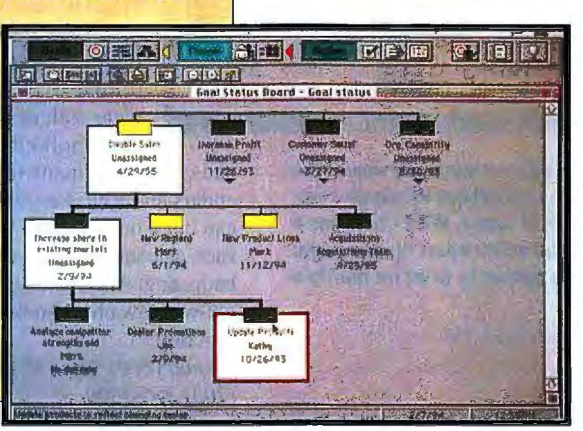
An embedded and customizable control bar, RibbonCB ($99) provides buttons via which you launch applications and macros from within any Windows application. You can easily navigate among your applications, and you can capture mouse movements and keyboard commands while writing macros. From Software Interface Solutions (Boulder, CO), RibbonCB includes a pixel editor that lets you capture graphics off-screen for use as button faces.
Phone: (800) 266-5866 or (303) 651-6570.
Circle 1285 on Inquiry Card.

MANAGEMENT SOFTWARE FOR A CROSS-PLATFORM TEAM

Now available for the Mac, ManagePro 2.0 ($395) helps managers and workgroups meet their goals and deadlines by integrating tools for planning, tracking, and delegating tasks over a network. You enter information in spreadsheet-style planners, and the software automatically creates color-coded goal- and people-status boards, time lines, to-do lists, calendars, and more than 30 standard reports.

ManagePro prompts managers through a four-step performance management process and offers useful management tips and techniques. The software's calendar automatically shows, in all the calendar views, an item you entered elsewhere in the program, such as a project deadline entered in the goal planner. The multiuser capability provides simultaneous read/write access, synchronizing separately updated copies of the same database.

Contact: Avantos Performance Systems, Emeryville, CA, (800) 282-6867 or (510) 654-4600.
Circle 1272 on Inquiry Card.



Software Update

ImageFast 2.0, ImageFast Software Systems (McLean, VA), lets you



set up your own indexing and organize the information environment your way via the addition of the Database Design Wizard, Action Icons, WorkFast, Calera OCR integration, RedactFast, and unlimited annotation layers. From $195.
Phone: (800) 899-6665 or (703) 893-1934.
Circle 1296 on Inquiry Card.

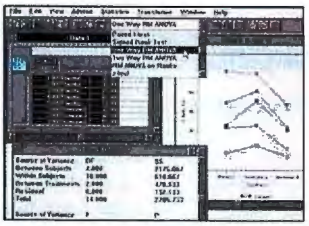
Teleform for Windows 3.0, Cardiff Software (Solana Beach, CA), adds a forms designer, BasicScript for implementing complex procedures, faster and more accurate hand-printing recognition, and TIFF support; improves fax tracking; and supports multiple fax phone books, among other improvements. From $1495.
Phone: (619) 259-6430.
Circle 1297 on Inquiry Card.

Director 4.0, Macromedia (San Francisco, CA), improves memory management, compiles its scripting language for faster script execution, optimizes data retrieval from storage devices, and adds object-oriented commands and a "movie in a window" feature. $1195.
Phone: (800) 457-1774 or (415) 252-2000.
Circle 1298 on Inquiry Card.

Synchronize 1.3, CrossWind Technologies (Felton, CA), builds on a cross-platform architecture and lets you easily customize your work space and change the appearance and behavior of the software to fit your own needs. $100 per user.
Phone: (408) 335-4988.
Circle 1299 on Inquiry Card.

NetCensus 2.00, Tally Systems (Hanover, NH), streamlines its GUI and adds the MacCollector to provide automatic hardware and software inventory; a product-detail table that organizes data in spreadsheet-like reports; reporting features; and a snap-in module for Novell's NMS. $10–$20 per PC.
Phone: (603) 643-1300.
Circle 1300 on Inquiry Card.

What's New Software



STATISTICS FOR WINDOWS ▲

Developed from the ground up for Windows, the SigmaStat for Windows statistical software package ($495) helps you select the most appropriate tests, checks your assumptions, handles missing data, and explains the tests' statistical results. From Jandel Scientific (San Rafael, CA), the software's procedures include descriptive statistics; *t*-tests; analysis of variance; correlation; *z*-tests; chi-square tests; nonparametric methods; linear, multiple linear, and nonlinear regressions; power; and sample size. Data-import options include text, spreadsheet, database, SigmaPlot, and SigmaStat files. The software automatically creates a comprehensive report for all statistical procedures you invoke.
Phone: (800) 874-1888 or (415) 453-6700.

Circle 1286 on Inquiry Card.

OS/2 LINK

XoftWare/32 for OS/2 ($395) lets users of networked PCs and PS/2s access graphical and character-based Unix applications and display them concurrently with OS/2 programs on a single PC screen. The AGE Logic (San Diego, CA) software includes the company's Professional Edition Utilities, full X11.5 compliance, cut-and-paste capability for exchanging information between a PC and a Unix host, a fully interactive Telnet client, and the ability to reroute multiple Unix print requests to any printer on your PC network.
Phone: (619) 455-8600.

Circle 1287 on Inquiry Card.

WINDOWS MULTIMEDIA HELP

You can visually and quickly integrate multimedia into your Windows help system with Multimedia WinHelp ($199). The program lets you add voice, sound, or video to your help system and extends the functionality of the Windows help engine. You can use the program with or without a Windows help authoring tool. From Blue Sky Software (La Jolla, CA), the program supports .AVI and .WAV files and includes the Video for Windows 1.1 run-time version.
Phone: (800) 677-4946 or (619) 459-6365.

Circle 1288 on Inquiry Card.

MULTIPLATFORM CHANGE FILES

A multiplatform file-update utility, UpdateIt ($249) lets you ship to your customers incremental product updates in the form of compressed password-protected change files. A full GUI front end for building and maintaining change files lets you create a single file that will update an entire directory tree. From Innovative Data Concepts (Hatboro, PA), UpdateIt can create raw change files or stand-alone .EXE programs as Windows, OS/2 character-mode, Presentation Manager, or DOS applications.
Phone: (800) 926-4551 or (215) 443-9705.

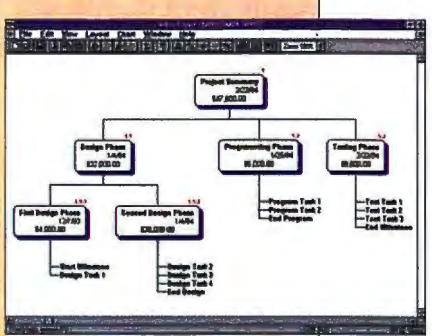
Circle 1289 on Inquiry Card.

MONEY MANAGEMENT IN WINDOWS

Managing Your Money for Windows ($79.95) from Meca Software (Fairfield, CT) furthers a recent trend in small office/home office software to deliver better ease of use than you get with the usual boxed icons. When it's enabled, the Smart Desk interface is a full-screen configurable office, complete with desk drawers, shelved books, and countertop items (e.g., calendars and Rolodexes) that you can click on to invoke modules such as banking, investing, and budgeting. Also featured is a single-window checkbook/register function.
Phone: (800) 820-7458 or (203) 256-5000.

Circle 1290 on Inquiry Card.

INSTANT WBS



A fully featured Windows program, WBS Chart for Project ($149) lets you create, edit, and print WBS (Work Breakdown Structure) charts directly from Microsoft Project. The WBS Chart feature automatically generates a WBS chart from your current project when you open the project file in Microsoft Project and select the WBS Chart option in the File menu. The software expands and collapses summary tasks and displays either a summary view of the project or all levels of project detail. To support any Windows-compatible printer or plotter using any size of paper, WBS Chart has a fit-to-page option that lets you print the entire chart on one page; if you prefer, you can choose the Tile option to print on multiple pages.

Contact: Jim Spiller & Associates, Fairfield, CA, (707) 425-2484.

Circle 1273 on Inquiry Card.

Software Update

TrueCAD for Windows 2, Choice Computing (Mountain View, CA), adds more than 40 features, including the ability to read and write AutoCAD .DWG files directly, a Power Bar, an Alignment dialog box, a Nudge feature, symbol insertion with horizontal and vertical mirroring, Symbol Ghosting, easy DDE interaction with other programs, improved bit-map handling, and improved support for plotters and printers. $295 until June 30; $395 thereafter.
Phone: (800) 828-2770 or (415) 428-0131.

Circle 1301 on Inquiry Card.

Common Ground 1.1, No Hands Software (Belmont, CA), adds an embeddable Windows Mini-Viewer and JPEG compression; it supports Apple's Macintosh Easy Open and PowerTalk software, which is based on the Apple Open Collaborative Environment technology. $99.95.
Phone: (800) 598-3821 or (415) 802-5800.

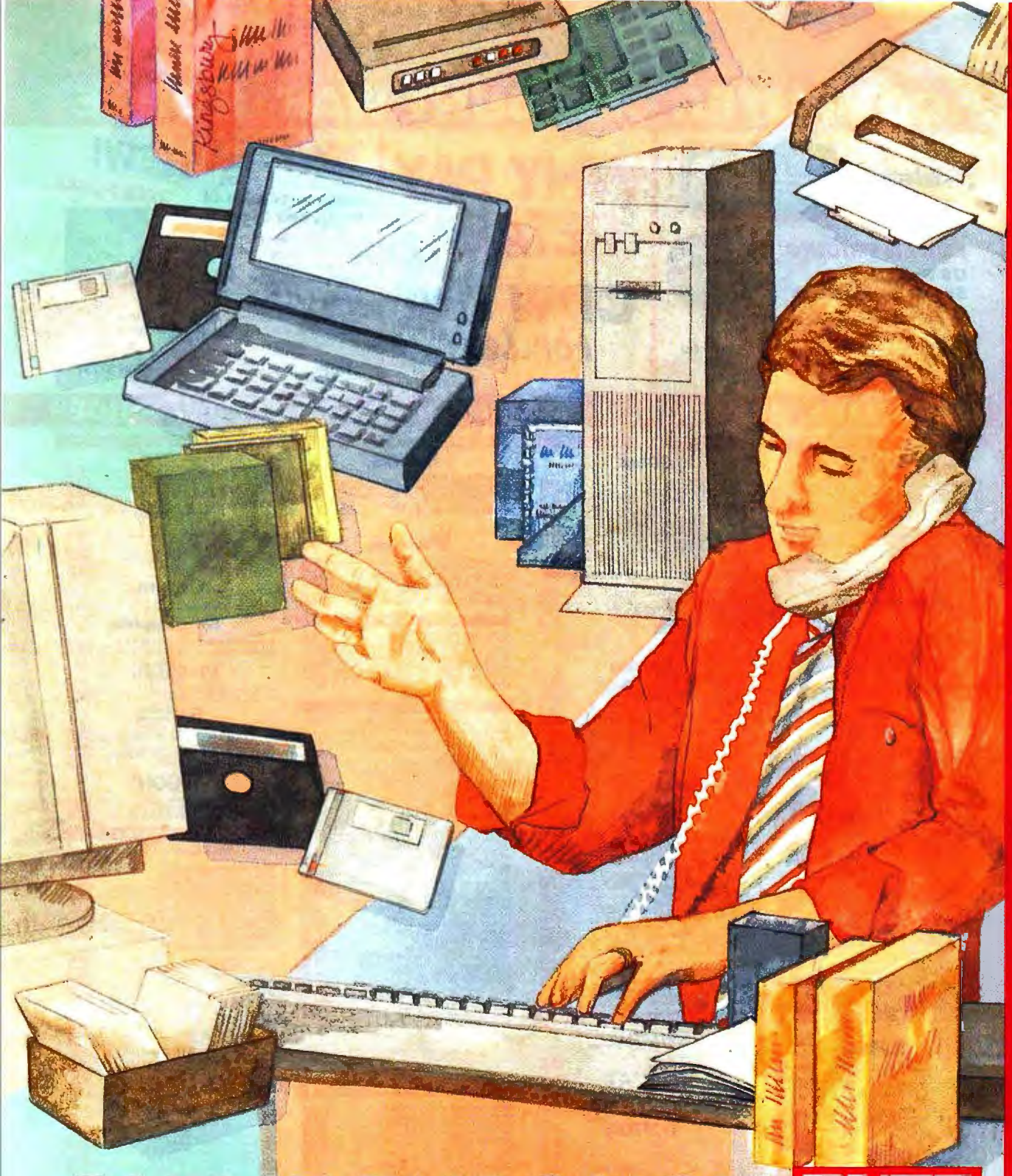
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The Major BBS 6.2, Galacticomm (Fort Lauderdale, FL), provides a GUI using RIPscrip, refines File Libraries, adds full-screen ANSI file tagging, enhances compatibility with CD-ROM drives, redesigns the Polls & Questionnaires feature, and includes QWK-mail, letting you access the program with modem speeds of up to 28.8 Kbps. $259 for two users.
Phone: (305) 583-5990.

Circle 1303 on Inquiry Card.

Versions 1.1, Omega Systems (Irvine, CA), adds the Project Wizard, automatic project-based scheduled check-in, streamlined project maintenance, selectable long and short menu styles, function-key shortcuts to commonly used dialog boxes, the ability to cancel an operation during error situations, and other features. $279.
Phone: (714) 440-3646.

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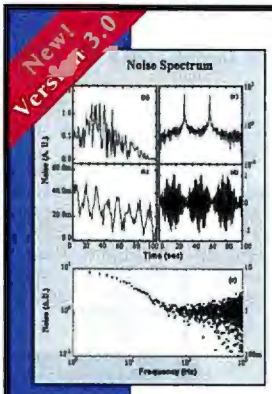
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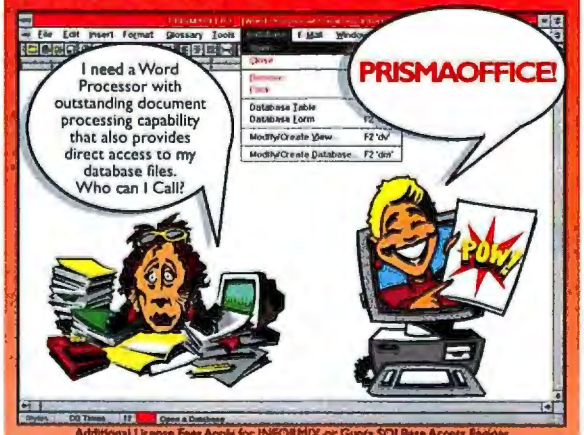
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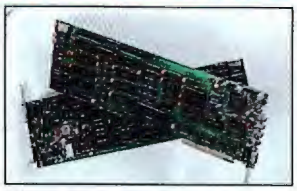
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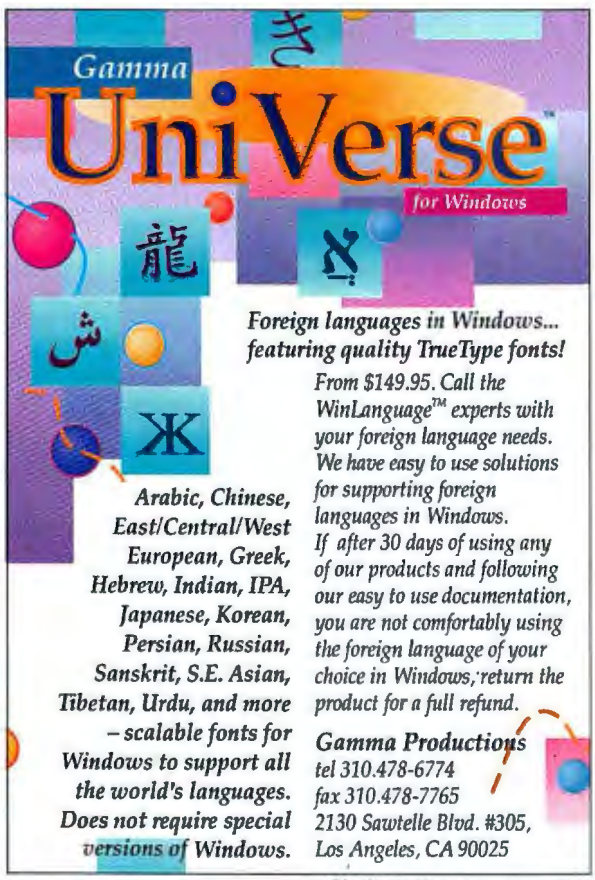
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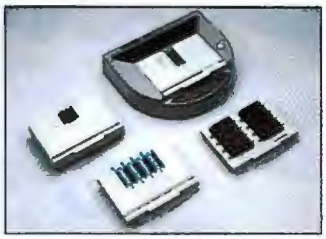


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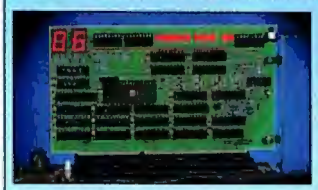
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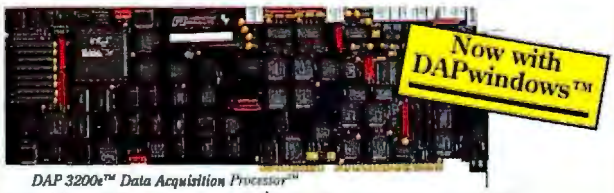
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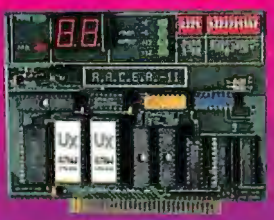
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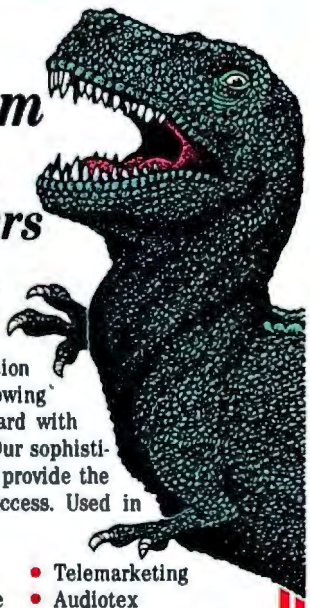
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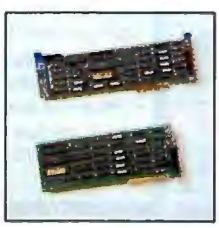
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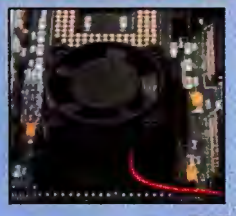
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	1Meg Module	113646-001	79.00
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DeskPro 386/20E	1Meg Exp Bd	113644-001	149.00
DeskPro 386/25E	4Meg Exp Bd	113645-001	279.00
	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	219.00
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T2000SX/T1000LE	4Meg	PC-PA8314U	189.00
T2000SX/T1000LE	8Meg	PC14-PA8315U	359.00
T2000SXE/2200SX/T1800, 1850, C	2Meg	PC-PA2000U	94.00
T2000SXE/2200SX/T1800, 1850, C	4Meg	PC-PA2001U	189.00
T2000SXE/2200SX/T1800, 1850, C	8Meg	PC-PA2002U	359.00
T4400SX, SXC T8400, T6600	4Meg	PC-PA2004U	199.00
T4400SX, SXC T8400, T6600	8Meg	PC-PA2005U	379.00
T4400SX, SXC T8400, T6600	16Meg	PC-PA2010U	699.00
T4500 C, T4600, T4700, T1900 C, T1910, T1950 (3.3 v)	4Meg	PC-PA2012U	209.00
T4500 C, T4600, T4700, T1900 C, T1910, T1950 (3.3 v)	8Meg	PC-PA2013U	419.00
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T5100	2Meg	PC7-PA8301U	95.00
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AUR Venture	4Meg	12407980	249.00
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AST Power Exec 3/25C, 425EL	4Meg		199.00
AST Power Exec 3/25C, 425EL	16Meg		819.00
AST Power Exec 425SL	4Meg	501166-001	199.00
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	8MB	6450130	$348
PS2/2 35SX; LS; 40SX	8MB	6450129	$348
PS2 70's and 80's	2-8MB	6450605	$297
32 BIT BOARDS	2-16MB	34F3077	$388
32 BIT BOARDS	4-16MB	34F3011	$318
PS/2 80-A21; A31; A61	4MB	6451060	$248
PS/2 80-041	4MB	6450375	$88
PS/2 80-111; 311; 121; 321; 081; 161	2MB	6450379	$94

IBM Laptop Memory

Thinkpad 300, Ambra Treka	2MB	33G9288	$128
	8MB	33G9289	$409
Thinkpad 350, 350C	8MB	6060378	$358
	16MB	6060379	$668
Thinkpad 700T	2MB	33G6958	$138
	4MB	33G6959	$298
	8MB	33G6960	$499
CL57SX	2MB	07G1419	$168
Thinkpad 700, 700C, 720, 720C	4MB	07G1420	$198
	8MB	07G1421	$398
Thinkpad 710T, 750, 750C	4MB	N/A	$198
	8MB	N/A	$398
PS/Note N45	2MB	92F8804	$108
PS/2 Model N51, Notebook SLC, SX	2MB	07G1826	$102
	4MB	07G1827	$198
	8MB	07G1828	$418
Laptop N33SX, L40SX & PSNOTE 182	2MB	79F0999	$98
	4MB	79F1000	$198
L40SX, PSNOTE 182 ONLY	8MB	79F1001	$348

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T2000SX/T1000 LE	2MB	PA8314U	$188
	8MB	PA8315U	$368
T1200 XE	2MB	PA8306U	$98
T1600	2MB	PA8302U	$98
T2000 SXE/T2200SX/T1800 T1850, C	2MB	PA2000U	$98
	4MB	PA2001U	$188
	8MB	PA2002U	$368
T3100	2MB	PA7135E	$178
T3100 E	2MB	PA8341U	$118
T3100 SX	2MB	PA8308U	$108
	4MB	PA8310U	$204
T3200 SX	2MB	PA8307U	$118
	4MB	PA8309U	$214
T3200 SXC	2MB	PA8318U	$108
	4MB	PA8319U	$224
T3200	3MB	PA7137U	$186
T3300SL	2MB	PA2006U	$118
	4MB	PA2007U	$238
	6MB	PA2008U	$298
	16MB	PA2009U	$718
T4400 SX, SXC, T6400 SXC, DXC	2MB	PA2003U	$125
	4MB	PA2004U	$198
	8MB	PA2005U	$378
	16MB	PA2010U	$698
	32MB		$1999
T4500, T4600, T1900C 3.3VOLTS	4MB	PA2012U	$208
	8MB	PA2013U	$428
	16MB	PA2014U	$878
T5100	2MB	PA8301U	$104
T5200/T5200C/T8500	2MB	PA8304U	$109
	8MB	PA8313U	$418

COMPAQ Memory

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Deskpro 386/16	1-2MB	108069-001	$238
	2MB	108069W71	$448
	4-8MB	108070-001	$398
Deskpro 286E, 386-20, 20E; 25, 25E	1MB	113131-001	$59
	4MB	113132-001	$208
Deskpro 386S	4MB Board	113634-001	$299
	4MB Module	112534-001	$248
Deskpro 386-20E; 25E	4MB	113645-001	$299
Deskpro 386/33; 386/33L; 486/25; 33L;50L; Systempro	2MB	115144-001	$104
	8MB	116561-001	$428
	32MB	116568-001	$1458
Systempro; Deskpro ..... 6 SKT EXP BRD W/2MB		116569-001	$279
Compaq "M1"	2-64MB	129160-001	$278
Deskpro 286N; 386N; 386SX/20; 20N, Portable 486c, Deskpro M , Systempro LT Series 129160-001, Compaq Pro Signia	1MB	118688-001	$49
	2MB	118689-001	$84
	4MB	118690-001	$178
	8MB	128877-001	$368
Prolina 3/25 & 25Z	2MB	141738-001	$98
	8MB	141742-001	$318
Prolina 4/25si, 4/33, 4/50	2MB Module	141683-001	$94
	4MB Module	141684-001	$178
	8MB Module	141685-001	$364
Compaq Pro Signia	16MB	149320-001	$684
	32MB	149147-001	$1524
DeskPro 5/60, 5/66M	8MB	149911-001	$388
Prosignia 5/60	16MB	149949-001	$738
Proliant 100 5/60	32MB	149912-001	$1598
Proliant 2000 4/30, 5/66	64MB	149913-001	$2698
Proliant 4000 4/50, 5/66	128MB	149914-001	$5848

Laptop & Notebook Memory

Contura 320, 325	2MB	139497-001	$98
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Contura 4/25CX	4MB	146520-001	$178
	8MB	146521-001	$348
	16MB	146532-001	$798
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	4MB	110237-001	$218
SLT386	1MB	118303-001	$79
	2MB	118304-001	$108
	8MB	118305-001	$218
Lte 286	1MB	117081-001	$79
	2MB	117081-002	$99
	4MB	117081-004	$208
Lte 3865/20	1MB	121125-001	$98
	4MB	121125-002	$238
Lte Lite/20, 25, 25C	2MB	129769-001	$138
	4MB	129769-002	$238
	8MB	129769-003	$398
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256X1 STATIC				$1.95	$2.25	
256 X 1	$1.45	$1.85	$2.40	$3.00	$3.15	$3.20
256 X 4			$6.45	$7.95	$8.45	$8.95
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CACHE MEMORY

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Compaq Pagemark 15 & 20	$98		$189	$388
Epson Action Laser II, 8000 .	$198		$238	$288
Epson + 6000 and many more	$118		$198	
Epson Action Laser 1000 & 1500	$138		$276	$399
Fujitsu 7100 & 7200	$199	$279		
HP Deskjet 500, 500C and 550C	$38 (256K)			
HP2, 2D,	$98		$164	
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Texiba Page Laser 6	$99		$168	
TI XL/PS17/PS35	$48			

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Dec pc 320 Notebook	2MB Mod	FR-PCIM-BA	$149
	4MB Mod	FR-PCIM-BB	$298
	8MB Mod	FR-PCIM-BD	$498
Dell Laptop 212, 320N; 320N+	2MB Mod	310-3204	$129
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Dell NL20 & NL25	2MB Mod	310-3213	$148
Epson NB-3 Notebook	4MB	AB08511	$198
Epson NB-5L/	2MB Mod	AB08771	$168
EPSON 25C Notebook	4MB Mod	AB08781	$228
Everex Tempo LX, LX20	2MB	00160	$98
Everex Carrier	2MB	00263-00	$108
Grid 1500	4MB	52587	$238
Grid 1450SX	2MB	62000203	$148
Goldstar GS520, 386SX16	1MB	N/A	$98
	4MB	N/A	$298
NCR 3120 Notebook	4MB Mod	3120-K104	$299
NCR 3170 Notebook	4MB Mod	3123-K104	$399
Packard Bell, Magnavox, Mitsubo	1MB	N/A	$108
	4MB	N/A	$298
Panasonic CF170/270/370	1MB	CF-BA165	$64
Samsung Notemaster 386S	2MB	SNM002	$195
	4MB	SNM004	$395
Sanyo 17NB; 18NB & ZEOS	2MB	MBC-NBMEM2	$98
Sharp 6220	1MB	CE-6218	$78
Sharp 6640,6781,6681,6785	4MB	N/A	$198
Sharp 4700MZ-200	1MB	CE-471	$198
Sharp 8501 Colorstar	2MB	N/A	$398
TI Travelmate 2000	1MB	2568034-0011	$78
TI Travelmate 3000SX; WINSX	2MB	2566996-0001	$88
TI Travelmate 4000, WINDX/25 SX/16, SX25, DX2/40	4MB	2581265-001	$298
DX2/50	16MB	AVAILABLE	$1540

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BRAVO 3/25'S	2MB	500710-004	$98
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ADVANTAGE 386SX/20,25, PRO SX/25 BRAVO 3/33'S	2MB	500962-001	$88
	8MB	500962-002	$348
ADVANTAGE PRO 486DX/33;SX/25, BRAVO LC 4/25S; 33; 33S; 50D; 4/660	2MB	500987-001	$108
	4MB	500987-002	$178
PREMIUM 386/25; 33; 33T II 386SX/16;20;25	1MB	500780-003	$59
	1MB	500780-002	$59
ADVANTAGE 486/25; 33;33P;50D, BRAVO 4/33;486/25;PREMIUM 4/25; 33TE, SE 4/33	2MB	500718-004	$98
	2MB	500780-005	$98
ADVANTAGE 486/25;33;33P;50D,POWER PREMIUM 3/33,4/33,33S;50D;660; PREMIUM 386/33TE,486/25,E,25TE;33,33TE; PREMIUM II 386/25;33,486/33,486SX/20			
PREMIUM SERVER SE 4/33	4MB	500780-004	$178
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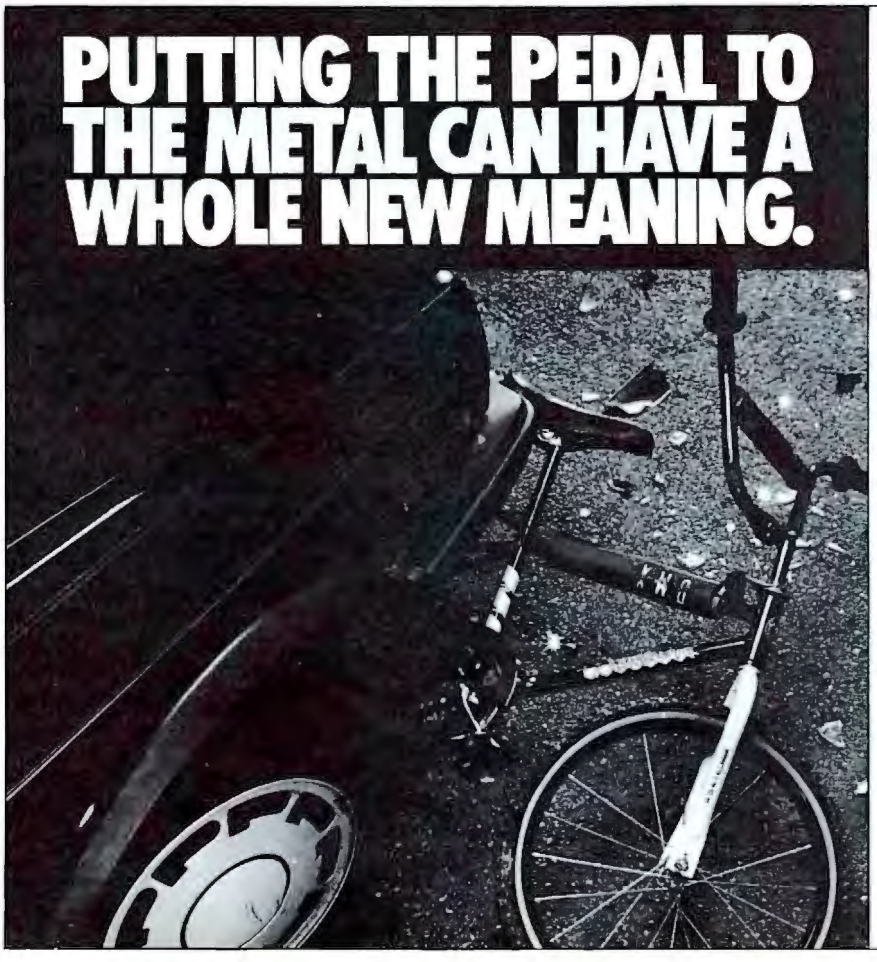
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October 1993 BYTE/NSTL LAB REPORT

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95222	80486DX 33MHz w/CPU	$549.95
79214	80486SX 25MHz w/CPU	$289.95
82333	80386DX 40MHz w/CPU	$239.95
82350	80386DX 33MHz w/CPU	$219.95
101821	80386SX 33MHz w/CPU	$124.95
84945	XT 10MHz w/CPU	$79.95

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41371	41256-100	256KBx1	$1.95
41398	41256-120	256KBx1	$1.85
42251	511000P-80	1MBx1	$6.49
42219	511000P-10	1MBx1	$6.25

SIPPS



41700	421000A9A-70	1MBx9	$54.95
41718	421000A9A-80	1MBx9	$49.95
41697	421000A9A-10	1MBx9	$47.95

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41523	41256A9B-80	256KBx9	$14.95
41486	41256A9B-10	256KBx9	$14.95
41689	421000A8B-80	1MBx8	$49.95
41742	421000A9B-60	1MBx9	$57.95
41751	421000A9B-70	1MBx9	$54.95
41769	421000A9B-80	1MBx9	$49.95

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93382	SIPP Module Converter	$11.95

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78271	32-key keypad	$59.95
17128	101-key enhanced	$74.95
17135	130-key enhanced	$99.95

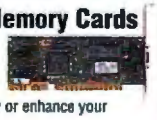
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67467	200 Watt (8088)	$89.95
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19529	200 Watt mini	$89.95
65728	300 Watt	$139.95

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104660	Super VGA Card	$89.95
91230	Monochrome Graphics	$39.95
29313	32MB Memory card	$144.95
19975	(8088) Memory Card	$49.95

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28716	PPC6	6' - straight cable	4.95
28708	PPC12	12' - straight cable	8.95
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31721	SAT6	9-pin serial cable	4.95

DB25-Pin Extension Cable

39538	25M10M	Male to male	6.95

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- Additional accessories available

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74384	FD235J	2.88MB 3.5"	119.95
40774	356KU	1.44MB 3.5"	79.95
17099	FD55B	360KB 5.25"	89.95
17101	FD55G	1.2MB 5.25"	99.95
79396	SD540	360KB 5.25"	59.95

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19895	8088 Multi I/O w/ Floppy Cntr.	$69.95
19908	286/386 Multi I/O w/ Floppy Cntr.	59.95
19596	8088 Floppy controller	29.95
19617	Floppy Disk Two-drive controller	34.95
19668	Floppy Disk Four-drive controller	44.95
78713	Serial Card 16450 UART	29.95
67053	Serial Card 16550 UART	39.95
104578	Serial Card - 4 serial port UNIX	79.95
104109	I/O Card 4 Serial, 3 parallel	69.95
105611	I/O Card	44.95
105072	VESA IDE Super I/O Card	79.95

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- One-year warranty

93286	CP30174E	170MB	$249.95
93294	CP30254	250MB	299.95
93307	CP30544	545MB	599.95

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10233	ADP20	16-bit hard	$24.95
10250	ADP20F	16-bit hard/floppy	29.95
10268	ADP50	8-bit hard	59.95
10276	ADP60	16-bit hard w/ BIOS	69.95
10284	ADP60F	16-bit hard/ floppy w/ BIOS	74.95
74114	ADP65F	16-bit hard/quad floppy drive adapter	99.95
101670	ADP90VL	Super I/O Card (VESA)	99.95

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33611	TMS2716	6.95
40002	2716	3.95
40125	2732A-25	4.19
40230	2764A-20	4.49
39829	27C64-15	3.75
39933	27128-25	7.75
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15712	DE4	8-Chip eraser	$89.95

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104441	Serial Mouse	13.95
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106121	PS2/AT 106-Keyboard (82)/ keypad (24) set	59.95
106391	Universal serial/parallel converter	69.95
109049	16-bit IDE hard disk controller	17.95
105208	PC to TV Converter Box	199.95

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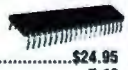


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73525	Portable IC Tester	$149.95

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26147	MM54104N	$24.95
26227	MM58274N	7.49
43158	6402	4.95
43166	65CO2	5.95
43254	6522	3.75
43598	6821	1.95
51844	8031	3.59
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53057	8749H	9.75
53081	8751H	24.49
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- 2.5" High Red Displays • 6-Digit Display

Kit includes: PC board, components, wall transformer and complete instructions (183 pieces)

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105507	Digital clock kit	$69.95
109241	Black case & red lens	29.95

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Will not crack or split when drilled or punched. PCB mounting slots on all four sides and the lid has a lip for precision fit (adds 0.4" H). Complete with four screws and lid. Color: black

Part No.	Size (L x W x H)	Price
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18913	4.875" x 2.5" x 1.5"	2.49
18892	6.0" x 3.5" x 1.875"	2.95
18905	7.5" x 4.25" x 2.25"	3.49

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The Jameco Prototype Boards are designed to fit into ABS Speedy Boxes. These pre-cut boards will allow the builder an immediate start on prototyping circuits. Each board has 2 or 4 mounting holes. Drilled holes: .040" dia. on .080" square pad on .10" x .10" spacing solder mask.

NEW



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105128	4.40" x 2.00"	18913	5.95
105152	5.50" x 3.10"	18892	6.95
105161	7.00" x 3.60"	18905	8.95
106551	Mntg. Hdwr. Kit. (4 sets)		1.19

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Bare bones system includes motherboard, computer case and power supply

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- Memory expandable to 32MB
- FCC approved • One-year warranty

95151	486DLC 40MHz	$419.95

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20511	Desktop slide case	49.95
20520	Desktop flip top case	39.95
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20546	Mini vertical case w/ 200 Watt power supply	119.95

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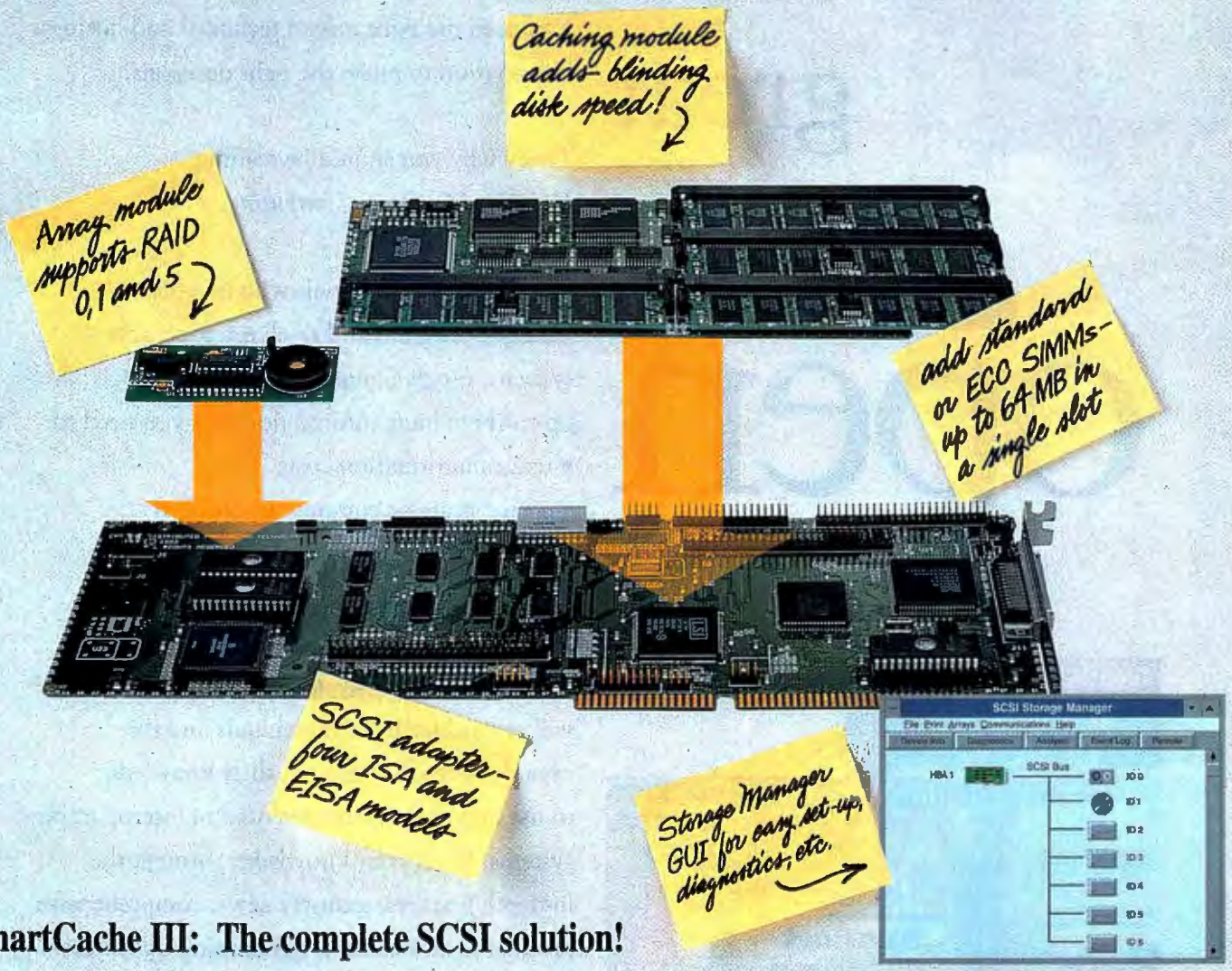
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TYPE	MB	SIZE	SEEK	PRICE
SCSI				
ST3390N	341	1"	12	$ 339
ST3550N	456	1"	12	$ 470
ST3655N	545	1"	11	$ 490
ST31200N*	1050	1"	9	
ST11200N*	1050	3.5	11	
ST11900N*	1700	3.5	9	CALL!!
✓ST11950N*	1700	3.5	8	PRICES
ST42100N*	1900	FH	13	
✓ST12550N*	2145	3.5	8	TOO GOOD
ST12400N*	2100	3.5	9	
ST42400N*	2106	FH	10	TO PRINT
ST43400N*	2912	FH	10	
✓ST15150N-W*	4100	3.5	8	
ST410800N-W**9080		FH	11	
IDE				
ST3145A	130	1"	16	$ 172
ST3243A	212	1"	16	$ 196
ST3290A**	260	1"	16	$ 218
ST3391A	341	1"	12	$ 260
ST3550A	452	1"	12	$ 314
ST3655A**	545	1"	12	$ 413

CONNER 3YR WARRANTY

TYPE	MB	SIZE	SEEK	PRICE
CFA170S-A	170	1"	13	$ 195
CFS210A	212	1"	12	$ 198
CP30254H	250	1"	14	$ 222
CFA340S-A	340	1"	12	$ 305
CFS420A	420	1"	14	$ 292
CFP1060S	1060	1"	9	$ 759

QUANTUM 2YR WARRANTY

TYPE	MB	SIZE	SEEK	PRICE
LPS270S-A	270	1"	16	$ 247
LPS340S-A	340	1"	12	$ 268
LPS540S-A	540	1"	10	$ 436
PD1225S	1225	3.5	10	$ 884
PD1800S	1800	3.5	10	$ 1000

WESTERN DIGITAL 2YR WARRANTY

TYPE	MB	SIZE	SEEK	PRICE
IDE				
WD2250	245	1"	14	$ 221
WD2340	340	1"	13	$ 268
WD2420	420	1"	13	$ 280
WD2540	540	1"	13	$ 392

DEC ✓7200RPM 5YR WARRANTY

TYPE	MB	SIZE	SEEK	PRICE
SCSI				
DSP3107L	1050	1"	9.5	$ 770
✓ VP3107	1075	1"	8	$ CALL
DSP3210	2100	3.5	9	$ 1458
✓ VP3215	2150	1"	8	$ CALL
DSP5400	4000	FH	12	$ 2452
✓ SP3430	4300	3.5	9	$ CALL

MICROPOLIS 5YR WARRANTY

TYPE	MB	SIZE	SEEK	PRICE
SCSI				
4110	1005	1"	9	$ 740
2217	1750	3.5	10	$ 985
1936	3050	FH	12	
4410	4100	3.5	8	
1991	9080	FH	11	CALL!!
IDE				PRICES
2210A	1035	3.5	10	
2217A	1750	3.5	10	TOO GOOD
AUDIO VIDEO				
2210AV	1050	3.5	10	TO PRINT
2217AV	1750	3.5	10	

SPECIALS 5YR WARRANTY

MB	SIZE	HT	PRICE
1GB	3.5	1"	$ 740
1.7GB	3.5	HH	$ 985
2GB	3.5	HH	$ 1430
3GB	5.25	FH	$ 1950

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ORM-1804X	18 CD MINICHANGER	4X SPEED	$ 1990

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TAPE DRIVES

TYPE	MB	SIZE	SEEK	PRICE
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WANGDAT	3200	4-8 GB	4MM	$ 930
WANGDAT	3400	8-16 GB	4MM	$ 1040
SONY	SDT2000	2 GB	4MM	$ 780
SONY	SDT4000	2-4 GB	4MM	$ 840
SONY	SDT5000	4-8 GB	2MM	$ 988
DEC	DLT 4060	20 GB	DLT	$ 3175
EXABYTE	8205	2.5 GB	8MM	$ 1357
EXABYTE	8505	5 GB	8MM	$ 2070

MULTI MEDIA CD-ROM Bare Drives

TYPE	MS	SIZE	SEEK	PRICE
CHINON CDS535	280	2X	256 K cache	$ 320
TOSHIBA 4101	280	-	-	$ 219
TOSHIBA 3401	200	2X	256 K cache	$ 315

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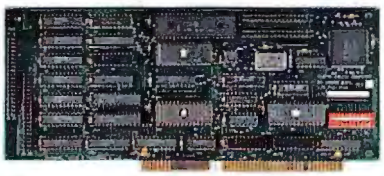
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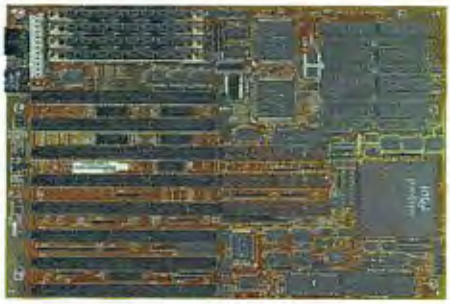
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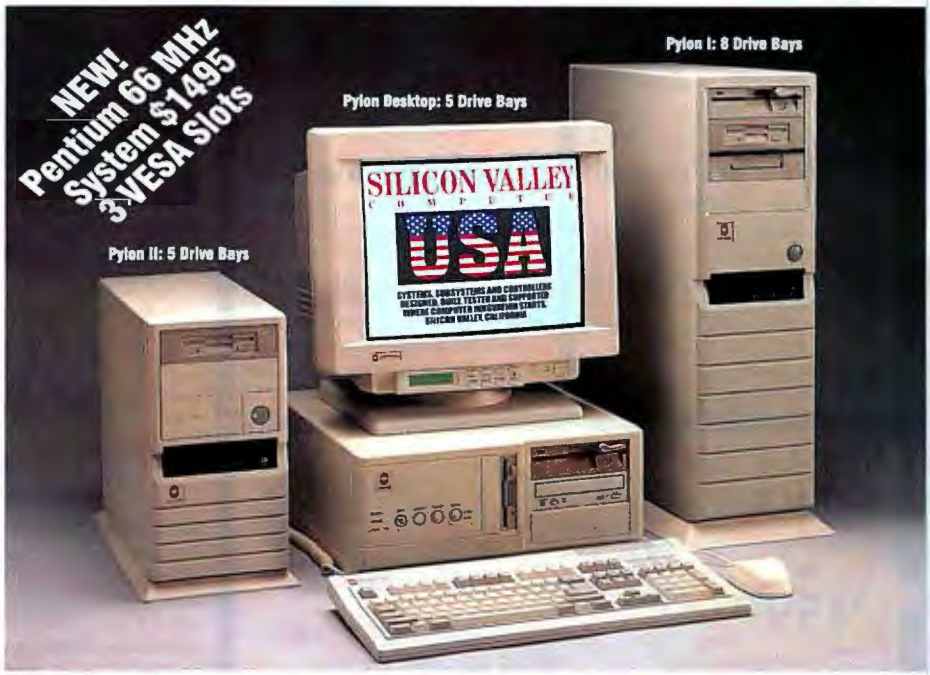
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	4MB 118690-001	$181	8MB 112877-001	$354
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	PowerLine Workstation 420; 425; 433; 450; 450DE/2, 466DE			
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NEW	PowerLine Workstation 420; 425; 433; 450; 450SE/2, 466SE			
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	Performance T, L, & M series			
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	4MB 92F9694			$168
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	PS/1 Consultant, Essential, Expert models x76			
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	PS/2 25/286, 30/286, memory adapter 1497259			
	2MB Kit 30F5360			$81
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	2MB 6450604			$85
	PS/2 70-A21; A61; B21; B61, PS/1 Consultant, Essential, Expert models x11, x13, x14, PS/Valuepoint Cxx series			
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	PS/2 90 XP, 95 XP, P75 (pairs), 56, 57 (all), PS/1 Pro M2123			
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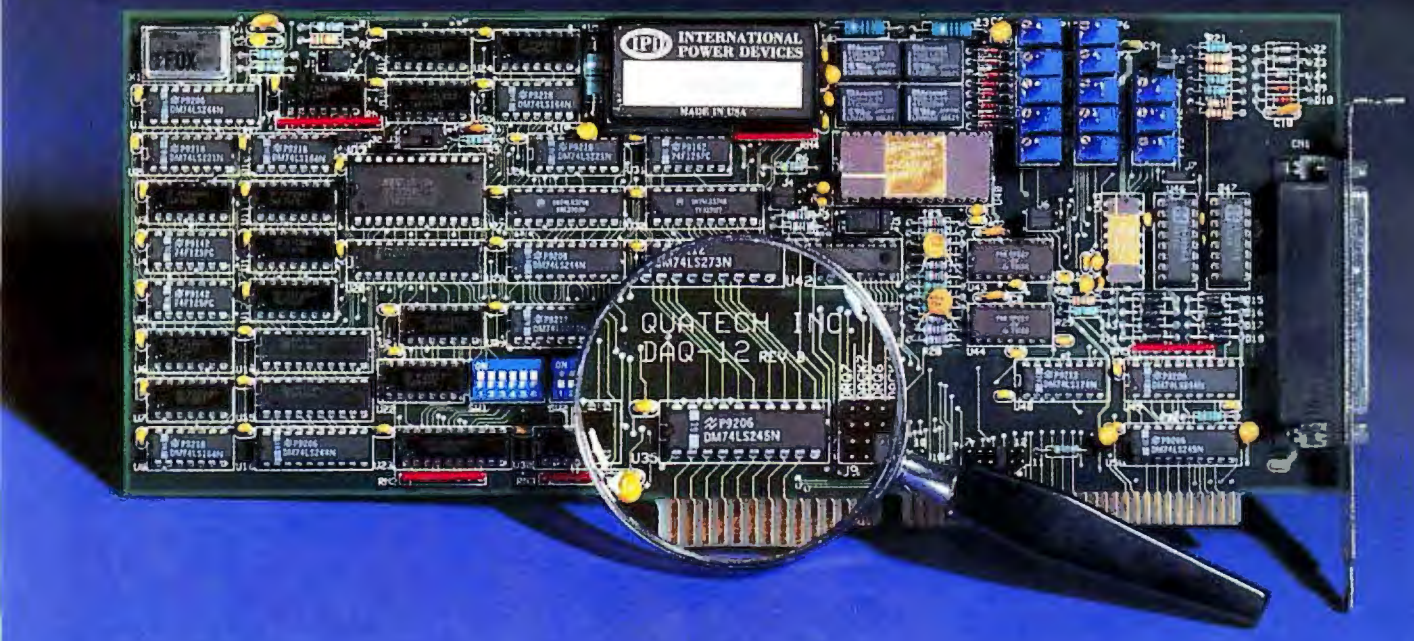
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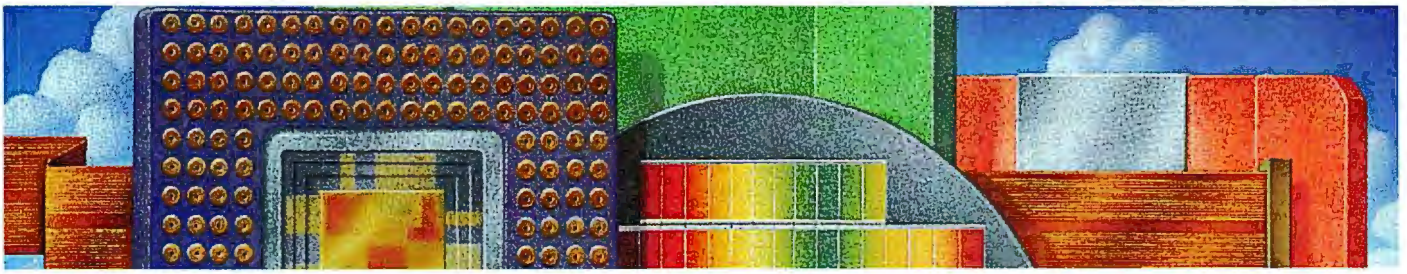
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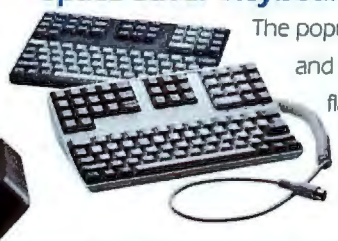


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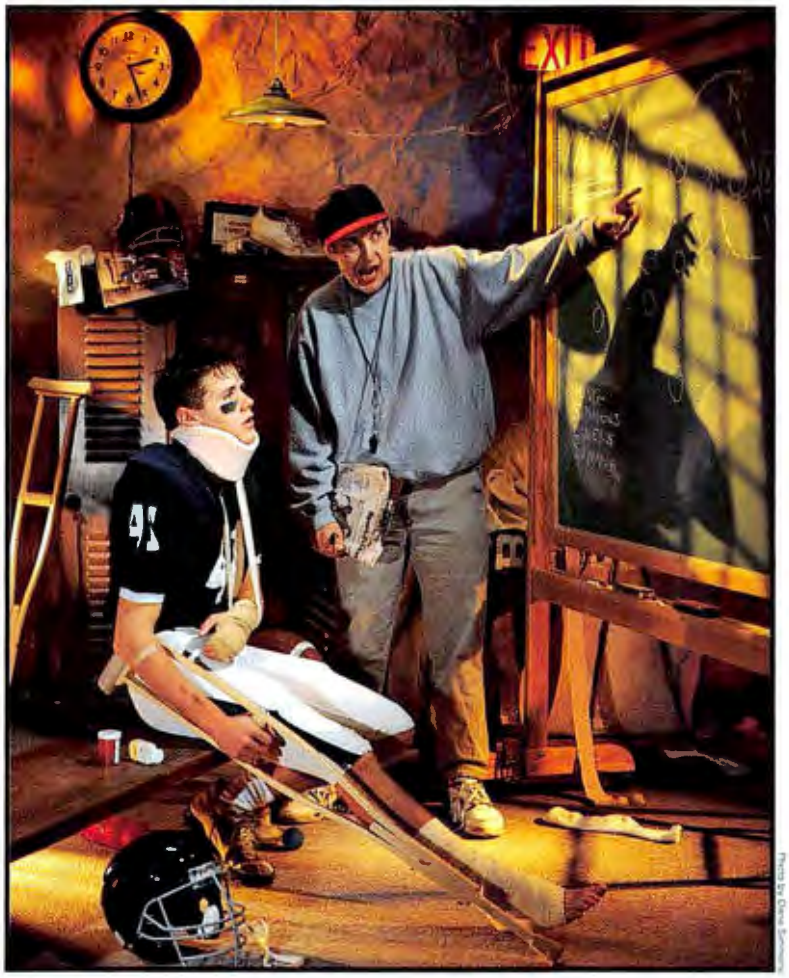
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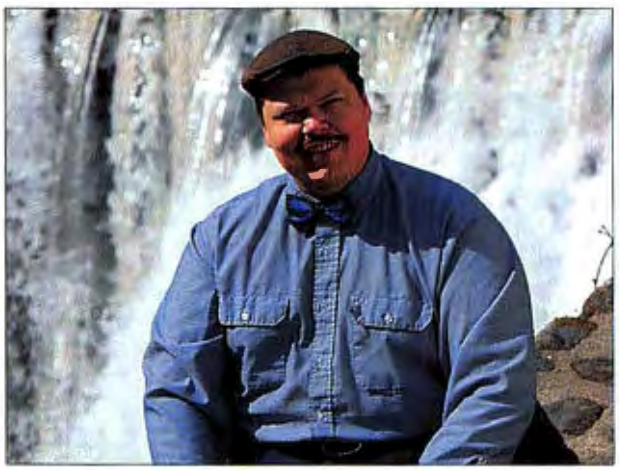
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Think Multiplatform

Portable code and flexibility are key to successful software development



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It is exceedingly easy to develop a narrow world view focused on a specialized segment of technology. Almost every potential client seems to want a specialist with a minimum of 10 years experience—Mac Toolbox, Windows API, Novell, telecommunications, IPC, RPC, the list goes on. My favorite is a request for an experienced Newton MessagePad developer, which appeared on AppleLink about two months after the Newton's release. There must have been all of two or three in the world at the time.

The problem with being a specialist is that you're locked into a smaller world; it's easy to lose sight of the fact that there are few homogeneous computing environments out there. I believe that flexibility is the long-term key to survival as a consultant.

I keep reading that Windows is ubiquitous and the Mac is—once again—doomed. Never mind those poor, isolated souls running OS/2 or Unix. Just design your applications to run on Windows and you can conquer the world. My company's experience with real-world clients offers proof to the contrary. During the last several years, the bulk of our contracts have involved porting applications from one platform to another. And the majority of our porting work has required moving applications from Windows *to* the Mac.

At first this was a surprise, even though I dearly love the Mac and think everybody should have one. The basic issue behind this move from Windows to the Mac is not that the customer's applications are not doing well under Windows, but that the Mac continues to appear throughout corporations in growing numbers.

Last year, IDC did a survey of computer use in small, medium, and large corporations. It found that 60 percent of the companies surveyed had Macs installed, which is a significant market presence.

Although I've focused my discussion on Mac versus PC, many forces are at work in the marketplace. Windows NT wants to become the corporate server of choice and looks like it will be driving the move to standardized multiprocessor platforms. The PowerPC may add new life to Unix on the desktop, and OS/2 sales are increasing. According to an article in the *Wall Street Journal*, OS/2 sales are small compared to those for Windows, but sales have been increasing since the release of Windows NT. Is there a platform you can afford not to support?

Exciting changes are taking place off the desktop, as well. Corporate reengineering is in full swing, with the result that more and more desktop machines need to talk to central corporate platforms—VAX, AS/400, and the like. You know the world is changing when IBM runs ads showing how flawlessly the Mac connects to its AS/400 systems. Users have also become mobile, with laptops, hand-held computers, and PDAs (personal digital assistants) becoming much more prominent.

But what does this mean from the point of view of a software engineer? You must be ready to take your code anywhere with minimal notice. The need to write programs that run within multiple operating systems and hardware platforms is becoming the norm, not the exception. To cope with this, your design and development efforts must be based on the premise that the code will operate in multiple environments.

Simply put, design and develop portable code. There's nothing magic about writing portable code. Design short, modular functions. Separate the user interface from the computationally intensive internals. Isolate your platform-specific calls under generic wrappers.

When you're debugging, use every available tool to provide automated code checking. Have other people comment on your code. Learn to accept and give constructive criticism. It is difficult to know everything, particularly when you are fielding applications on multiple platforms. Last, but by no means least, document, document, document.

I know there's nothing new in this advice. However, I am continually amazed at the amount of code my company inherits that cannot even make it through a moderate warning-level check from the compiler or that ties pieces of the user interface into all levels of the code.

Of course, some products should not be designed for multiplatform operation. But for the majority of new applications, if you plan their move to multiplatform support from the start, you'll have a flexible product that's better able to take advantage of the shifting market realities. ■

Raymond GA Côté is a BYTE consulting editor and vice president of product development at Appropriate Solutions, Inc. (Peterborough, NH). He can be contacted on the Internet at rgacote @world.std.com or on BIX c/o "editors."

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